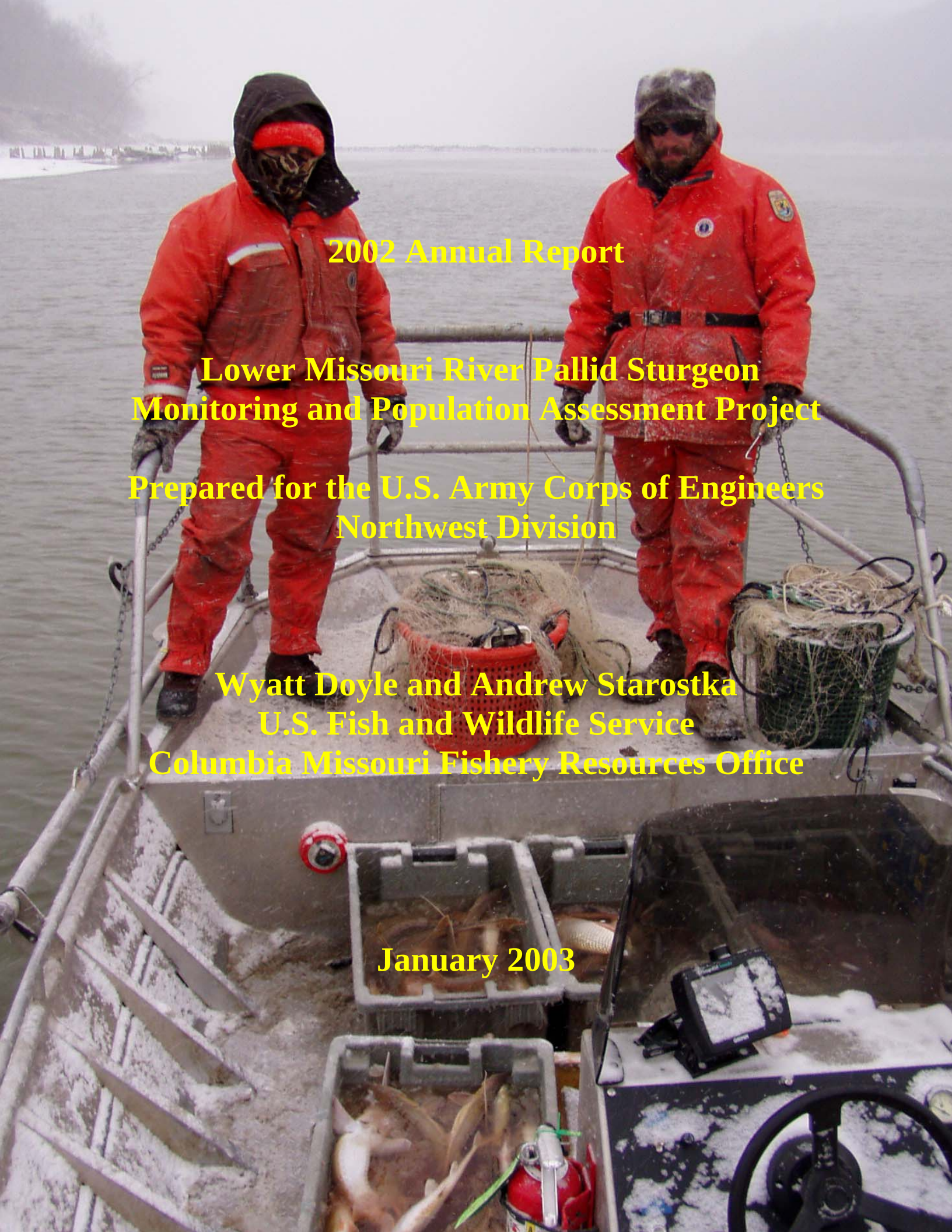

2002 Annual Report

Lower Missouri River Pallid Sturgeon Monitoring and Population Assessment Project

Prepared for the U.S. Army Corps of Engineers
Northwest Division

Wyatt Doyle and Andrew Starostka
U.S. Fish and Wildlife Service
Columbia Missouri Fishery Resources Office

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Abstract

The Columbia Missouri Fishery Resources Office (CMFRO) began a three-year project funded by the Northwest Division, Kansas City and Omaha Districts, U.S. Army Corps of Engineers (COE) to monitor and evaluate pallid sturgeon populations on the Lower Missouri River starting in Spring, 2001. For 2002, CMFRO targeted six sampling reaches along 200 river miles. Sampling was conducted from December 2001 to October 2002. Sites were sampled with gill nets, trawls, seines and mini-fyke nets. Twelve pallid sturgeon, 12 hybrid pallid sturgeon, 3044 shovelnose sturgeon and 28 lake sturgeon were collected among 27,903 fish sampled.

Eight of the 12 pallid sturgeon caught were presumed to be wild. Two of the eight wild fish were recaptures; one was recaptured 1.3 miles from its initial capture site 3 yrs earlier and had grown only 4mm; another was recaptured in the same dike scour hole where it had been tagged one month before. Seven adult pallids were caught in gillnets and five juvenile pallids were captured in trawls. Three of the juvenile pallids were associated with an island tip, one was caught along a revetment above the same island and the other was captured behind a notched L-dike. Four of the juveniles were from a recent stocking of 2352 hatchery produced fish. Three had PIT tags designating their origin and one had a scar from a lost or failed PIT tag. The other juvenile was presumed to be wild (no PIT tag or scar).

Pallid sturgeon continue to decline at a rapid rate. Within the 200 river-miles sampled, the ratio of pallid to river sturgeon decreased from 1:311 in a 1996-2000 study to 1:387 in 2002. Median lengths of shovelnose remained consistent with previous studies, suggesting commercial harvest is not yet affecting the overall population structure.

Relative abundance of shovelnose and pallids were higher at the Overton Bottoms reach than in any other. Seven of the twelve pallids collected came from this area. Numerous dike modifications in this reach may have been important in creating good over-wintering sturgeon habitat relative to other unmodified reaches. At Overton Bottoms, young of the year (YOY) paddlefish were caught for the first time this year by CMFRO. They were captured in a unique L-dike field along with juvenile pallid, lake and shovelnose sturgeon. The L-dikes had deep notches allowing higher flows which created shallow sand bar habitat on the inside of the L-dikes. The dike field is an example of a useful modification the Corps of Engineers can incorporate in its continued efforts to create habitat for sturgeon.

Seventy-four juvenile sturgeon (<300mm) including 15 larval sturgeon were collected in trawls throughout the summer and fall sampling period. Catch rates of adult, young of year and juvenile shovelnose were higher along main channel sand bars compared to other habitats sampled. There was some evidence that a trend exists for higher catch rates of shovelnose with increasing depth of scour holes in winter gill-net sampling.

Introduction

Pallid sturgeon (*Scaphirhynchus albus)* abundance has declined throughout the Missouri River since dam construction and inception of the Bank Stabilization and Navigation Project in 1912 (Carlson et al. 1985). Loss of habitat, reduced turbidity, increased velocity, loss of natural flows, reduction in forage, increased hybridization and inadequate reproduction and recruitment are factors contributing to the decline of the pallid and other native species (Pflieger and Grace 1987). Surveys conducted throughout the Missouri and Mississippi Rivers since 1996 show an increase in hybridization and continued decline of this species (Grady et al. 2001).

In an independent scientific evaluation of the condition and management of the Missouri River, the National Research Council (2002) concluded that altered flow and habitat conditions associated with current management practices on the Missouri River have resulted in an unhealthy river ecosystem. Earlier and similar conclusions presented in the U. S. Fish and Wildlife Service Biological Opinion recommended, in part, that the COE initiate modified flow regimes by 2003 to avoid jeopardizing three listed species (endangered pallid sturgeon and least tern; threatened piping plover) and begin restoring the river's ecological health. The COE is responsible for monitoring and evaluating biotic responses of the pallid sturgeon to operational and habitat changes on the Missouri River (USFWS 2000). Habitat restoration, higher spring and lower summer flows combined with adaptive management are recommended measures to restore pallid sturgeon populations on the Lower Missouri River. Adaptive management is an approach to natural resources management that promotes carefully designed management actions, monitoring and assessment of impacts and application of results and findings to subsequent policy and management strategies. Monitoring sturgeon populations will provide vital information needed to guide restoration of form and function (habitat and hydrology) in the Lower Missouri River.

In response to the 2000 Missouri River Biological Opinion, the COE is developing monitoring and restoration projects to avoid jeopardizing pallid sturgeon populations. As part of their Implementation Plan, the COE is working with the Columbia Missouri Fishery Resources Office (CMFRO) and State Resource Agencies to develop and conduct a sturgeon monitoring and assessment program. Objectives of this program are to document relative abundance, reproduction, recruitment, and distribution of pallid sturgeon in the Lower Missouri River; and biotic responses of pallid sturgeon and associated fish species to habitat and hydrologic changes. This report represents CMFRO's second year effort toward those objectives.

Hatchery production of pallid sturgeon has become a high priority as pallid populations continue to decline. In 2002, 13,711 pallids were stocked in the Missouri River, including 7849 in the Lower Missouri and 2696 within CMFRO's sampling reach (Personal Communication, Ryan Wilson, Bismarck Fish and Wildlife Management Assistance Office, February 2003). CMFRO attempted to capture some of these fish to evaluate movement, growth, and habitat and species associations.

Study Design and Locations

Five, ten-mile long primary monitoring reaches and one supplementary reach were sampled. Each primary study reach either encompassed areas where pallid sturgeon had been collected in the past or contained a habitat improvement project of potential benefit to pallid sturgeon. Primary reaches included: St. Charles (River Mile (RM) 20-30), Hermann (RM 95-105), Plowboy Bend (RM 170-180), Overton Bottoms (RM 180-190) and Lisbon Bottoms/Jameson Island (RM 210-220). Hartsburg (RM 156-166) was additionally sampled because several COE dike modifications had been done last year and CMFRO wanted to evaluate the production around these areas.

Monitoring and assessment activities were conducted over three temporal periods. The first of these was the December - March (winter/spring) time frame, which focused on sturgeon over-wintering habitat. The second was the March - June (spring/summer) period targeting sturgeon dispersal, migration, staging and spawning activities. The third interval covered the June-October (summer/fall) time period to evaluate larval and juvenile pallid sturgeon abundance, distribution and habitat associations as well as fish community information. Additional gill net sampling data was collected from Hartsburg, Overton Bottoms and Plowboy Bend as part of a USGS contract to collect pallid sturgeon for a telemetry study.

Methods

Standard gear and methods were used where possible in accordance with guidelines developed by the Middle Basin Pallid Sturgeon Recovery Work Group (MB-PLS-RWG) in cooperation with COE personnel as described in the draft document Pallid Sturgeon Population and Habitat Monitoring Plan for the Lower Missouri and Kansas Rivers, (Draft), (Drobish et al. 2001). Collection methods conformed with those described in Biological Procedures and Protocol for Collecting, Tagging, Sampling, Holding, Culture, Transporting and Data Recording for Researchers and Managers Handling Pallid Sturgeon (Krentz 2001). Federal Endangered Species Permits and Missouri State Wildlife Collecting Permits were obtained and maintained.

All gear types were not used across all seasons, all reaches or all habitat types. Gillnets were set in holes behind dike structures in the winter/spring months. Trawls were pulled in the summer/fall months across a variety of habitat types, which included revetments, dike holes, sand bars, main channel, tributary mouths and side channels. Mini-fyke nets and seines were set in the summer/fall months. Mini-fykes were set along sand bars and side channels and seines were pulled along sand bars only. All reaches were not sampled equally with any of the gears.

Gillnets

The nets used were 200' long x 8' deep consisting of two repeating series of 25' panels of multi-filament 1.5, 2, 3 and 4-inch bar mesh. The smaller mesh was set closest to the dike and the net was stretched downstream from notches or tips of wing-dikes and L-dikes into the scour holes created by the dikes. Scour holes varied from relatively no flow near the bank to high flow near the tips or notches. Nets were set at various depths and flows in an attempt to sample scour holes of all types. Nets were checked daily and moved after two days. The target effort for each reach was 20 net nights (nn). However, due to varying circumstances the target was not met or exceeded at different reaches: Lisbon (20 nn), Overton (29 nn), Plowboy (20 nn), Hartsburg (5 nn) (additional sampling reach), Hermann (13 nn), St. Charles (19 nn).

Trawls

Trawls were deployed from the stern of a 25 foot, 8.1 liter inboard, jet powered trawl boat or from the bow of a 22 foot, 130 hp outboard powered river-boat. The net was pulled downstream slightly faster than the current through a pre-designated habitat type. In an effort to keep samples distinct and comparable, the trawl was pulled over a constant depth, when possible, and retrieved at the end of specified habitat type. Four trawl configurations were used on an experimental basis to determine which would be most effective in capturing larval, juvenile and adult sturgeon as well as other species of all sizes.

The 3 slingshot balloon trawls and one beam trawl used had the following dimensions:

- 16-ft wide X 15-ft long; 1 ½ inch stretch mesh body; ¾ inch stretch mesh trawl bag; 1/8 inch diameter catch bag
- 22-ft wide X 22-ft long; 1 ½ inch stretch mesh body; 5/8 inch stretch trawl bag; ¼ inch diameter catch bag
- 22-ft wide X 22-ft long; 3 inch stretch mesh body, 1 ½ inch stretch mesh trawl bag; ¼ inch diameter catch bag
- 30 X 15 inch or 42 X 21 inch trawl doors were used with all otter trawls
- 2 meter beam with 1 ½ foot skids; 1 1/4 inch stretch outer chafing mesh; 1/8 inch diameter mesh inner cod. The inner cod zipped into the outer mesh about 2 feet from the mouth of the trawl

A 3/8 inch chain was lashed along the length of the foot-rope of the balloon trawl (otter-trawl) to ensure contact with the substrate and a 3-foot chain was attached to the cod end to prevent the net from rolling in the current during deployment. Fifty feet of floating rope with a buoy was attached at the cod end to help gauge pull-speed and allow retrieval of the net in the case of a snag.

The stern trawl boat was used at Overton and Lisbon Bottoms in June and July only. The bow trawling method was used in late summer and fall months in all reaches. The stern trawl enabled trawls to be used in short hauls to sample micro-habitats; such as dike holes, sand bar tips and heads and wing-dam sand bars. The bow trawling method consisted of longer trawls over long sand bars or main channel habitat. Structures such as dike holes and dike sand bars were still sampled but in less frequency than with the stern trawler.

Seines

The drag seines were 25 feet long by 8 feet high and constructed with black-dipped 1/4 inch Ace-type mesh. Seines hauls were conducted by extending the net perpendicular to the shore while pulling downstream for approximately 30 m before sweeping the channel edge of the seine back to shore.

Seines were primarily used at Lisbon and Overton Bottoms as part of another project. Additional sampling was done at Plowboy, Hermann and St. Charles for community comparisons. Samples were taken at various habitat types including: channel sides of unconnected sand bars, channel sides of connected sand bars, bank sides of unconnected sand bars, sand bar heads, channel bar tips, L-dike sand bars and side channels. Habitats were not sampled equally across reaches.

Mini-fyke nets

Mini-fyke nets are small Wisconsin-type fyke nets. Mesh was green-dipped 1/8 inch Ace-type nylon. Leads are 15 feet long and 2 feet high. Spring steel frames are 2 feet high by 4 feet wide with two internal wing throats. The cabs are constructed of two spring steel hoops, 2 feet in diameter containing two throats. Nets were deployed in areas where the lead and frames were in no more than 2 feet of water and set perpendicular to shore or angled slightly down stream when current velocities dictated. The leads, cod end and frames were staked or anchored as needed. Samples were taken only at Lisbon, Overton and Plowboy reaches, with most of the effort given to Lisbon because data was being collected for a Big Muddy Refuge project.

Data Collection and Reporting

Data was collected in accordance with the MICRA Pallid Sturgeon Protocol (Grady et al. 1996) and the Pallid Sturgeon Population and Habitat Monitoring Plan for the Missouri and Kansas Rivers (Draft), (Drobish et al. 2001) and recorded on MICRA standard field data sheets. Parameters include gear number, gear type, set time, pull time, soak time, river stage, discharge rate, habitat type, substrate, depth, turbidity, conductivity, water temperature, water velocity and location. These data were taken at the mid-point of trawl, seine and gillnet locations. River discharge (cf/s) data were obtained from a U.S. Geological Survey website giving hourly information from gauging stations along the River. The gauge referred to was the closest upstream from each sampling reach. GPS coordinates (latitude/longitude) were recorded at each sample site using a *Garmin 168* sonar or *GPS Map 76* Receiver. Beginning and ending coordinates were recorded for seines and trawls to determine distance; and for gillnets to determine direction of set. Minimum and maximum depths were recorded from a *Garmin 168* sonar throughout the length of the trawl or net set. Turbidity data (NTU's), temperature (EC), dissolved oxygen (mg/l) and conductivity (uS/cm) data were taken with a YSI 6820 multi-parameter meter. Two water velocity measurements (m/s) were taken at depth proportions of the water column by using the total depth as the max (bottom) and 80% (8/10) and 20% (2/10) of the

depth. A third velocity reading was taken at the bottom to represent the velocity at which sturgeon usually occur. All velocities were taken using a Marsh-McBirney model 2000 flow meter mounted to a downrigger which measured the depth off of a reel gauge. Lengths (mm) and weights (g) were recorded for fish collected. Small fish not identified in the field were fixed in 10% formalin and preserved in 80% ethanol. The fish were later identified and enumerated in a lab setting. All data were entered into CMFRO's station database. Statistical Analysis System (SAS 1990) was used to summarize the data as catch per unit effort (CPUE). CPUE was presented as Number fish/100m^2 for trawls, Number fish/10m^2 for seines and Number fish/net-day for gill nets and mini-fykes. Regression analyses and spearman rank correlations were also analyzed using SAS.

Results

Twelve pallid sturgeon (*Scaphirhynchus alba*) were captured in 2002. Eight were presumed wild and 4 were hatchery produced. Six were recaptures, evident by PIT (passive integrated transponder) or PIT scar (one stocked fish had a scar from a lost or failed PIT tag). Of the six recaptures, two were wild fish previously captured and tagged by FWS and Missouri Department of Conservation (MDC). The other 4 were hatchery fish which had been stocked at Boonville on April 11th, 2002. Tag retention studies at Gavins Point National Fish Hatchery suggest 90-95% of fish retained tags over several years. Tag retention is a very important component of future monitoring plans. Additional tagging methods to determine retention will be researched in the future (Personal communication, Herb Bolig, Gavins Point Hatchery Manager, February, 2003).

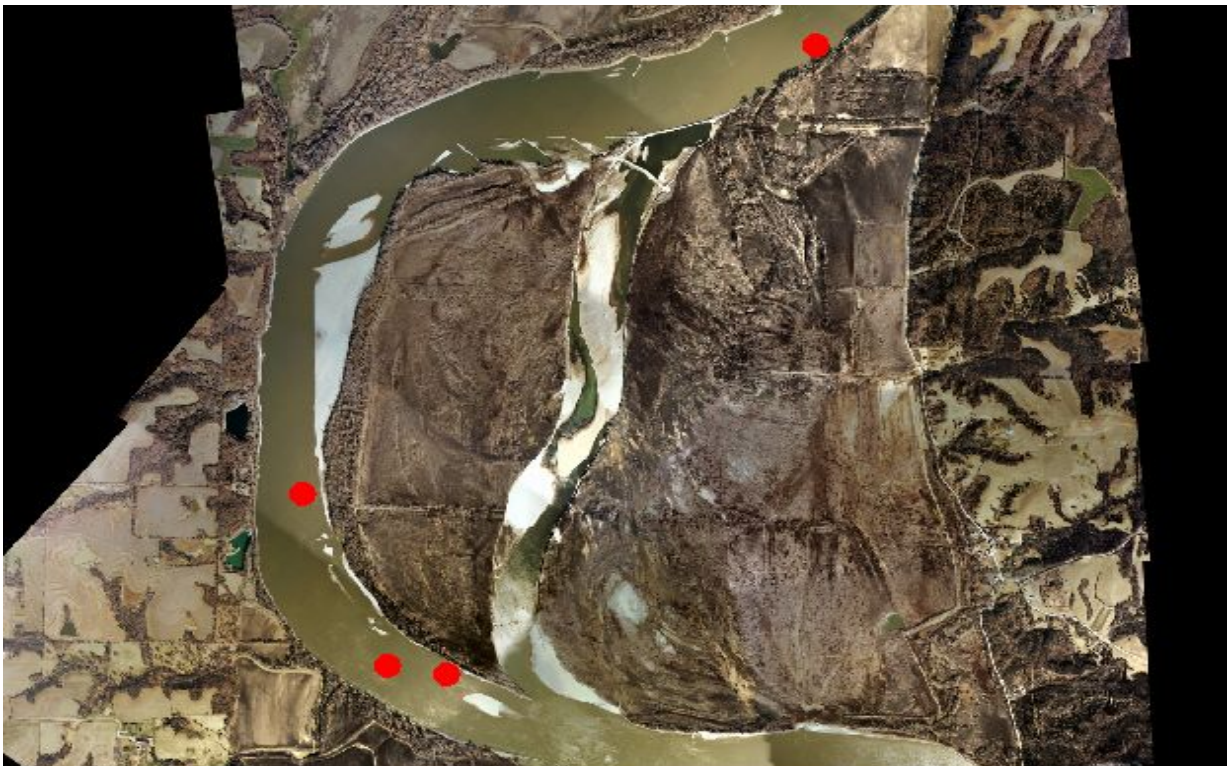
Pallid sturgeon captured in winter gill-nets

Five juvenile pallids were caught in trawls from June to October. Three were captured on island tip sandbars around Lisbon Island, one was caught on a revetment above the same island and one was caught behind an L-dike 20 miles downstream. Four of the 5 were hatchery fish. Lisbon chute is the only location where larval pallids have been found on the Lower Missouri River. Bottom water velocities ranged from 0.37 to 1.02 m/s at the point of capture and depths ranged from 1 to 5 meters (Table 1).

Seven adult presumed wild pallids were captured in gillnets from December to April. One pallid was captured at Lisbon in December and 6 were captured at Overton in March and April. Bottom water velocities ranged from 0.04-0.54 m/s and depths ranged from 1 to 13.44 meters (Table 1).

Table 1. CMFRO pallid sturgeon point-of-capture information from RM 20 to RM 220 in the Lower Missouri River, 2002. Bold numbers represent initial tagging information.

Date	Gear	River Mile	Length (mm)	Weight (g)	Recapture ?	Habitat	Minimum depth (m)	Maximum depth (m)	Bottom Velocity (m/s)
1/17/2002	Gill	222.7	715	1207	No	Wingdike Tip	1.22	3.05	0.54
3/13/2002	Gill	190.0	692	1256	No	Wingdike Tip	6.1	10.9	0.12
3/13/2002	Gill	186.6	820	1250	Yes	Wingdike Notch	3.7	11.3	0.06
2/19/2002		**186.6**	**820**		Wild				
3/13/2002	Gill	186.6	776	1962	No	Wingdike Notch	3.7	11.3	0.06
3/15/2002	Gill	185.1	928	3286	Yes	Wingdike Tip	1	2.4	0.04
2/26/1999		**186.4**	**924**	**3191**	Wild				
4/11/2002	Gill	183.0	755	1910	No	Wingdike Notch	10.08	13.44	N/D
4/11/2002	Gill	183.0	973	2873	No	Wingdike Notch	6.72	10.08	N/D
6/24/2002	Trawl	189.0	258	51	Yes	Inside notched	1	4	0.45
4/11/2002		**195.1**	**220**		Stocked	L-dike			
7/8/2002	Trawl	219.0	522	470	Yes	Revetment	5	5	0.87
4/11/2002		**195.1**	**467**		Stocked				
7/9/2002	Trawl	215.0	301	50	Yes	Island Tip	1	2	0.37
4/11/2002		**195.1**	**240**		Stocked				
7/10/2002	Trawl	215.0	231	20	Unknown	Island Tip	1	3	0.63
10/11/2002	Trawl	215.0	382	173	Lost Tag	Island Tip	2	2	1.02



Four red dots depict capture locations of 3 stocked and one untagged presumed wild pallid at Lisbon Bottoms Chute. Fish moved from 10-14 miles upstream from stocking site at Rm 195.1.

Wild pallid sturgeon ranged from 715 mm to 973 mm fork length. Two recaptured wild pallids showed little to no movement or growth between captures. One pallid was tagged in February 2003 by Missouri Department of Conservation (MDC) and recaptured one month later at the same wing-dike scour hole. The second recaptured wild pallid, originally tagged in February, 1999, was recaptured in March, 2002. It was recaptured 1.3 miles upstream from the original capture site. That fish had grown 4 mm in length during that time period and gained 95 g in weight. Two recaptured hatchery-produced fish had grown an average of 51 mm fork length during the 2 months between stocking and recapture.

Pallid sturgeon were stocked at five sites on the Lower Missouri River in April and November, 2002. There were 7849 pallids stocked from Gavins Point Dam, SD (RM 798.8) to Boonville, MO (RM 195) including; 282 at St. Helena (RM 798.8), 1841 at Mullberry Bend (RM 775.4), 215 at Ponca State Park (RM 753), 2815 at Bellevue (RM 601), and 2696 at Boonville (RM 195). Stocked pallids ranged from 175 mm to 611 mm with the majority averaging about 250 mm (Personal Communication, Ryan Wilson, Bismarck Fish and Wildlife Management Assistance Office, February 2003). Boonville was the only stocking (2696 fish) within reaches sampled by CMFRO. Of these, 2352 were stocked in April and 344 were stocked in November. Four stocked pallids were captured from two pre-designated monitoring reaches; 1 at 6 miles below (Overton L-dikes) and 3 at 16 miles above (Lisbon Island) the release point at River Mile 195.

The ratio of wild pallid to all river sturgeon collected in combined 2002 samples was 1:387 (N = 8:3099). All river sturgeon include shovelnose, pallid, hybrids and lake sturgeon. Data collected from 1996-2000 within the same reaches showed a ratio of 1:311 (N = 7:2177 sturgeon) (Grady et al. 2001). This data indicates wild pallid sturgeon numbers continue to decline. When hatchery stocked fish are included, the ratios are 1:258 in 2002 compared to a 1996-2000 ratio of 1:241 The contribution of hatchery fish, appears to be keeping the ratios constant and suggests current stocking rates in this reach may be adequate to stabilize the population over the short term.

Pallid sturgeon and hybrids were verified through a Character Index (CI) developed by Sheehan et al (1999) for fish in the middle basin of the Mississippi and Lower Missouri Rivers. The index summarizes a series of morphometric measurements and meristic counts to calculate a range of purity for each fish. Pallid hybridization with shovelnose did not appear to occur at the same frequency as found in previous years. In 2002 the ratio was 1 hybrid to 258 (N = 12:3099) river sturgeon compared to 1:155 (N = 14:2177) in Grady's study. This would suggest hybridization is decreasing. Since the Character Index measurements for hybridization are somewhat tedious and must be made in the field, only shovelnose that exhibit strong pallid characteristics are measured. Many fish that show some potentially intermediate characteristics may not be measured due to time constraints or personal subjectivity of the field crew. The decision to take Character Index measurements of a fish could directly affect the number of hybrid fish discovered throughout the year.

Spearman rank correlations were used to test for species associated with pallid sturgeon in gill net and trawl samples. This test looks at the frequency at which other species occur in the same samples as the species of interest. The test presents a probability and correlation coefficient,

which is the degree to which the variability is explained. Although some correlations were significant, the coefficient did not account for enough variability to be noteworthy, in that no correlation coefficients were greater than 9%.

Gillnets

Thirty-one species representing 3868 fish were captured in 135.2 net days of effort. Shovelnose sturgeon (*Scaphirhynchus platorynchus*) dominated gill net samples at 69% of the total catch. The average catch per unit effort (CPUE) for shovelnose was 22 fish per net day. CPUE for shovelnose sturgeon was highest at Overton Bottoms (42 fish/net day) and lowest at St. Charles (6 fish/net day) (Figure 1). Gillnets captured 7 wild pallids, 9 hybrids, 2665 shovelnose and 24 lake sturgeon. The median fork length for shovelnose sturgeon was 582 mm, which is consistent with 577 mm previously reported on the Lower Missouri River (Grady et al. 2001). Relatively stable mean lengths suggest that commercial harvest is not yet affecting the population structure of shovelnose in these reaches. Total numbers of fish captured were determined along with the relative percent abundance of each species for all sampling reaches (Table 2).

Lake sturgeon ranged in size from 234 mm to 971 mm fork length with a median of 710 mm. MDC has been stocking lake sturgeon for over a decade using different tagging methods and stocked fish were not tagged in some years. Eleven coded wire and 1 Floy tagged lake sturgeon were captured in 2002. MDC began PIT tagging captured lake sturgeon in 2000 and CMFRO will also in the future.

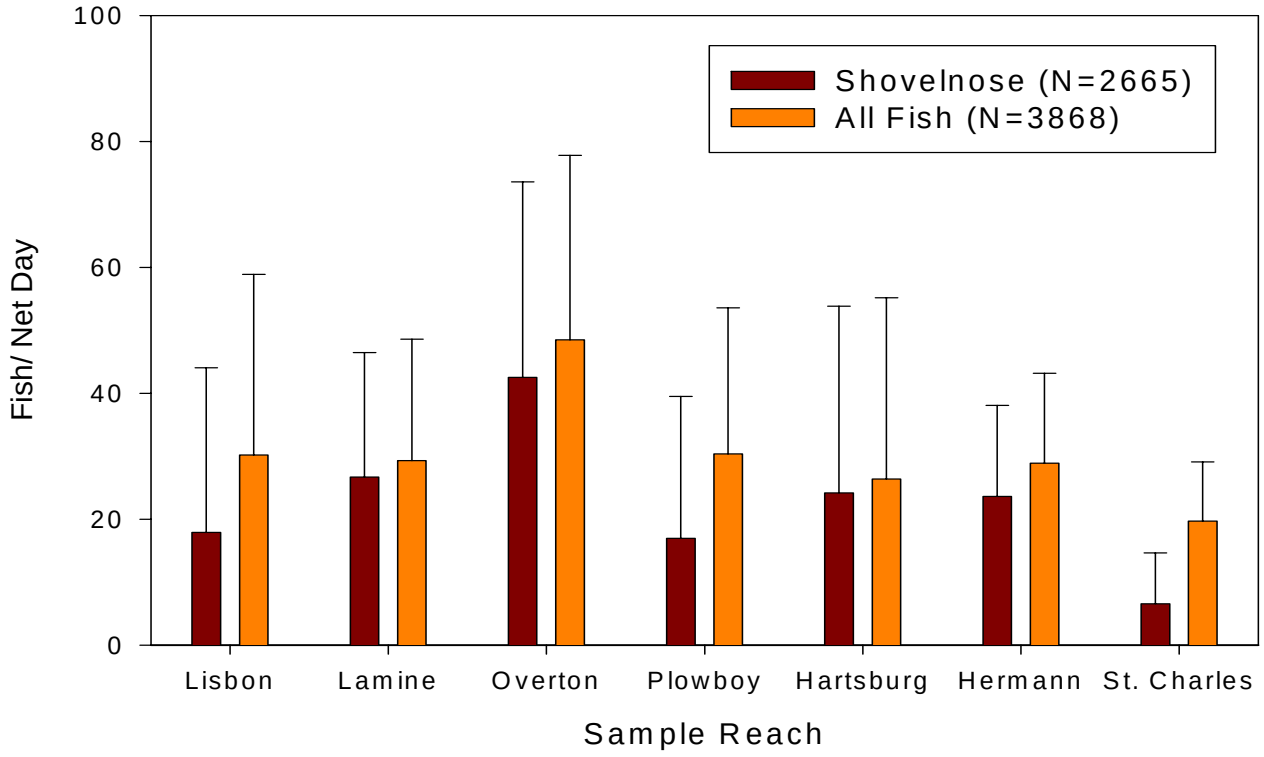


Figure 1. Catch per unit effort (CPUE) of shovelnose and all fish combined caught in gillnets on the Lower Missouri River in 2002.

Table 2. Total catch (TC) and percent relative abundance (RA) for each species collected by gillnets on the Lower Missouri River in 2002.

SITE	St. Charles		Hermann		Hartsburg		Plowboy		Overton		Lisbon		TOTAL	
RIVER MILES	20-30		95-105		156-166		170-180		180-190		210-220			
Species	TC	RA	TC	RA	TC	RA	TC	RA	TC	RA	TC	RA	TC	RA
Lake sturgeon	2	0.6	3	0.8	1	0.7	1	0.1	17	1.1			24	0.6
Pallid sturgeon									6	0.4	1	0.2	7	0.2
Pallid hybrid			3	0.8					6	0.4			9	0.2
Shovelnose stur.	118	33	307	82	134	89	417	53	1313	86	376	57	2665	69
Paddlefish	1	0.3	1	0.3	1	0.7	5	0.6	6	0.4			14	0.4
Longnose gar	1	0.3	1	0.3	1	0.7	1	0.1	6	0.4	10	1.5	20	0.5
Shortnose gar	1	0.3	1	0.3	1	0.7			2	0.1			5	0.1
Goldeye	30	8.4	20	5.3			182	23	69	4.5	123	19	424	11
Mooneye	5	1.4											5	0.1
Gizzard shad	25	7	1	0.3	1	0.7			5	0.3	1	0.2	33	0.9
Goldfish							1	T					1	T
Grass carp	2	0.6					3	0.4	1	0.1			6	0.2
Common carp					2	1.3	14	1.8	17	1.1	4	0.6	37	0.9
River carpsucker	19	5.3	1	0.3			6	0.8	16	1	3	0.4	45	1.2
Silver carp	1	0.3									1	0.2	2	0.1
Bighead carp							2	0.3	2	0.1			4	0.1
Quillback carp.					1	0.7	2	0.3	1	0.1			4	0.1
White sucker							2	0.3	3	0.2			5	0.1
Blue sucker							2	0.3	1	0.1	1	0.2	4	0.1
Smallmouth buff.	10	2.8	1	0.3			7	0.9	11	0.7	2	0.3	31	0.8
Bigmouth buff.	1	0.3					2	0.3	2	0.1			5	0.1
Golden redhorse									2	0.1			2	0.1
Shorthead red.	4	1.1	2	0.5			31	3.9	3	0.2	14	2.1	54	1.4
Blue catfish	94	26	31	8.2	3	2	23	2.9	25	1.6	60	9	236	6.1
Channel catfish	6	1.7	1	0.3			8	1	2	0.1	2	0.3	19	0.5
Flathead catfish					1	0.7	1	0.1	2	0.1	1	0.2	5	0.1
White bass	3	0.8							2	0.1			5	0.1
Striped bass hyb.							1	0.1	1	0.1			2	0.1
Sauger	18	5.1	3	0.8	1	0.7	67	8.5	11	0.7	65	9.8	165	4.3
Walleye	3	0.8					1	0.1					4	0.1
Freshwater drum	12	3.4			4	2.6	7	0.9	1	0.1	2	0.3	26	0.7
TOTAL	356		376		151		786		1533		666		3868	

T=Trace number of fish (i.e. < 0.1)

Linear regression analyses were used to determine if there was a relationship between CPUE of shovelnose in gillnets and depth or velocities. Linear regression looks at the tendency of CPUE to increase or decrease with the compared variable as it also increases or decreases and r^2 is the percentage of variability accounted for in that comparison. CPUE of shovelnose in gillnets suggests a trend for increased catch in deeper scour holes throughout the winter/spring sampling period ($P<0.0000$, $r^2=0.23$) (Figure 2). No significant relationship was evident between CPUE and velocity. However, Figure 3 suggests that catch rates increased moderately in velocities between 0.0 and 0.3 m/s. Increased catch coupled with decreased sampling effort shows higher CPUE at a specified depth range.

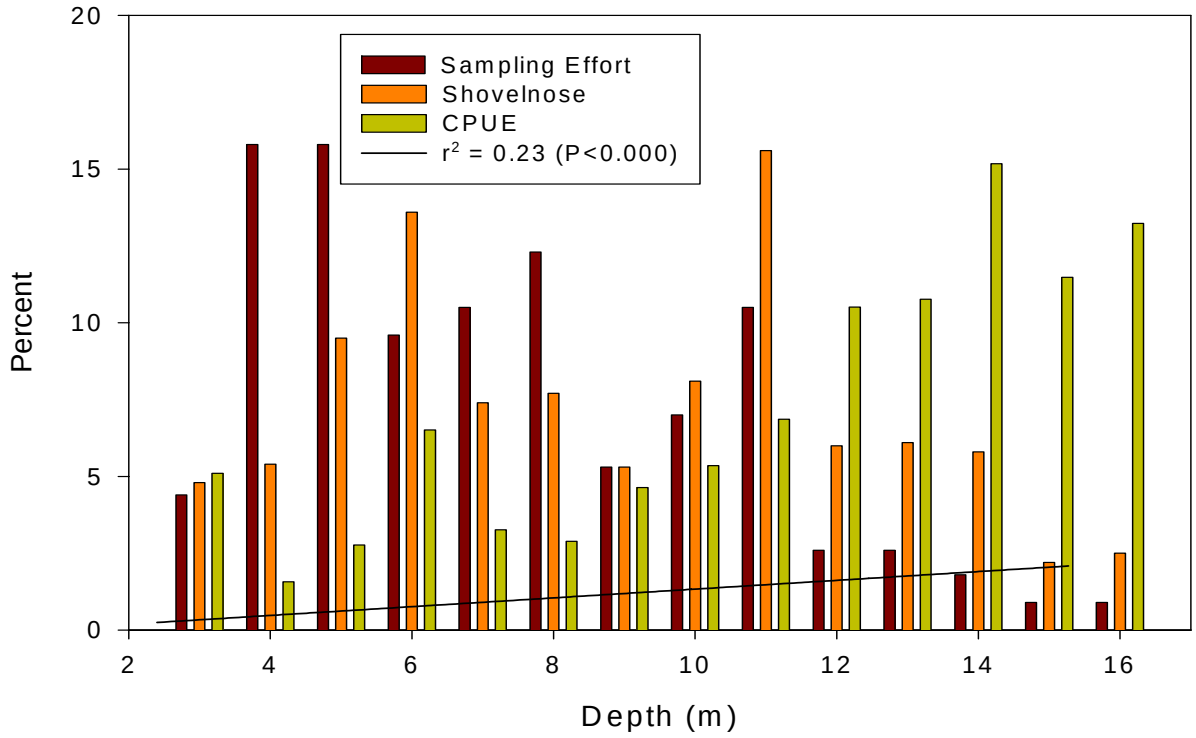


Figure 2. Percent of shovelnose sturgeon collected compared with sampling effort in depth ranges across all gillnet sampling effort on the Lower Missouri River for 2002.

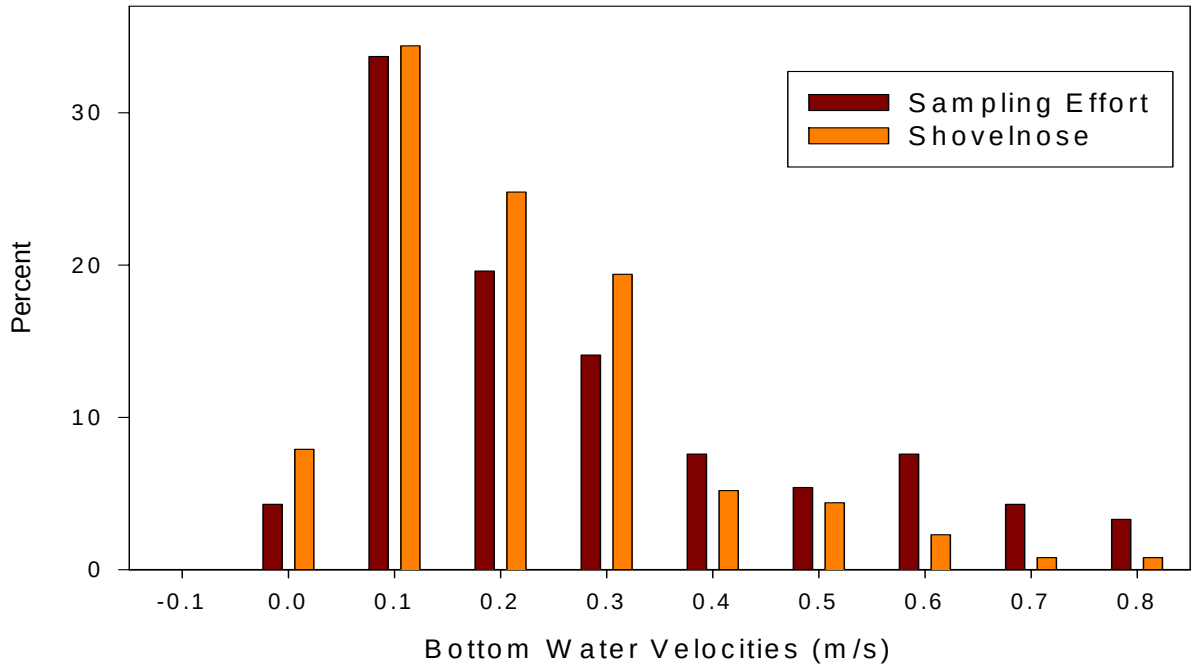


Figure 3. Shovelnose sturgeon CPUE compared to sampling effort across all velocity ranges sampled with gillnets in the Lower Missouri River in 2002.

Trawls

A total of 12,645 fish of forty-four species were collected in 7 beam and 221 otter-trawl hauls. Total numbers of fish captured were determined along with the relative percent abundance of each species for all sampling reaches (Table 3). Differences in fish captured between reaches may be explained by season variability or sample size. More effort is needed to determine trends in greater productivity between reaches.

Example of the various sizes and species caught in otter trawls

Channel catfish made up 29% and freshwater drum 27% of the combined total trawl catch. Shovelnose sturgeon were captured at an average rate of 0.13 fish per 100 m^2 of trawling. Fifteen young of the year (YOY) S*caphirhyncus* sturgeon were captured in trawls and are yet to be identified to species. Verification of suspected pallid sturgeon will be contracted to Darrel Snyder, Ph.D. at the Colorado State University Larval Fish Lab.

YOY blue catfish (N=1083) and channel catfish (N=3624) were abundant in many trawl samples. These are important game fishes in the Missouri River and their relative high abundance indicates good reproduction.

Adult blue sucker captured at St. Charles in an otter trawl

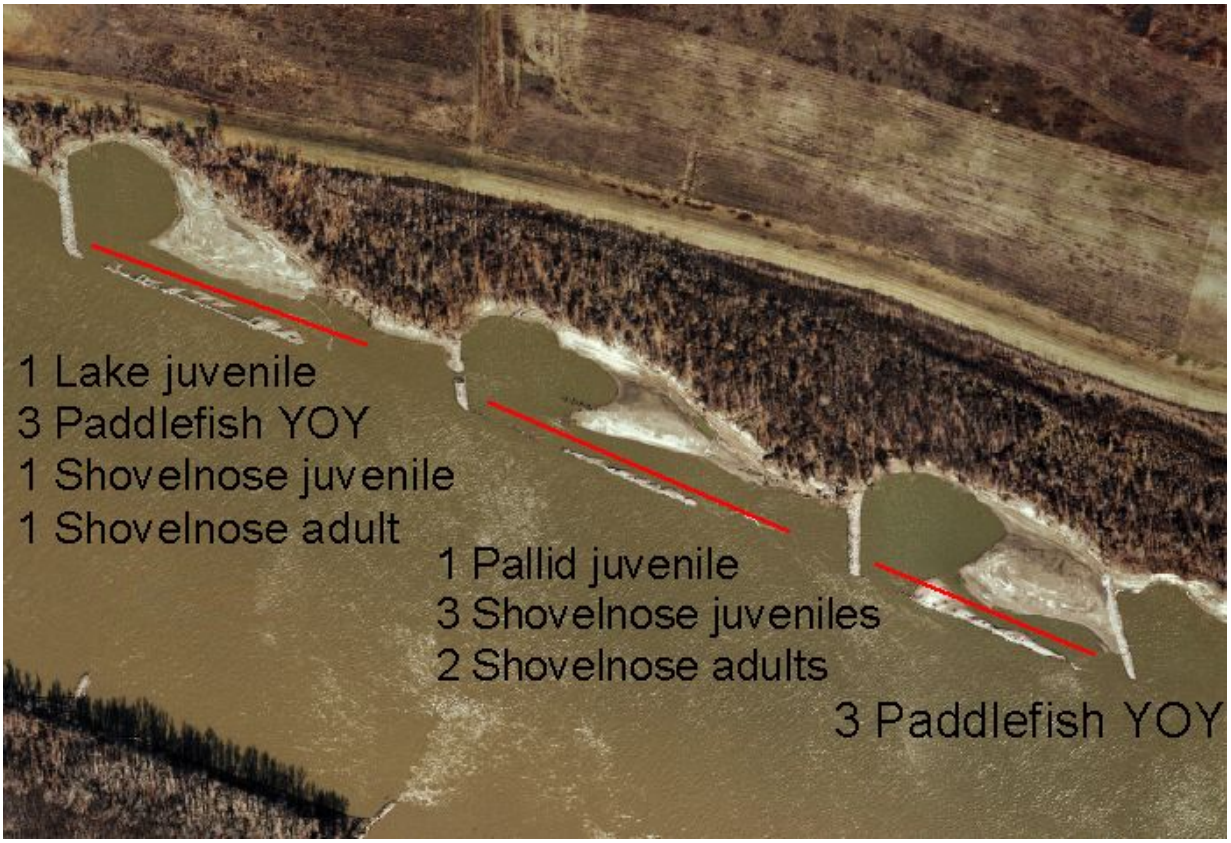
A total of 2475 chubs comprised of four species were collected. Sicklefin and speckled chubs made up 48% and 36% of total trawl catch and were most abundant and were often associated with sturgeon catches. Large adult silver chubs made up 12% of the chubs sampled and were primarily collected in the main channel trough where very few other species were found. Sturgeon chubs were the least abundant at 4% of the total.

Blue suckers, a priority species, occurred more frequently in trawls (N=19) than in gill nets (N=4). Blue suckers ranged from 51 mm - 760 mm, indicating the species is reproducing and recruiting.

Four juvenile lake sturgeon were captured in trawls associated with L-dike and wing dike sandbars. The substrates associated with the catches were sand, sand/gravel or silt. Bottom water velocities ranged from 0.02 - 0.73 m/s and depths ranged from 1 – 4 meters.

Young of year (YOY) paddlefish were collected for the first time this year by CMRFO. YOY paddlefish were caught in a unique L-dike habitat at Overton Bottoms. Typically, L-dike substrate is silt and velocities are near zero. The L-dikes were unique in the sense that the notches were wider and deeper than similar structures. These notches allowed enough flow behind the dike to expose a shallow protected sand bar. The paddlefish were associated with other juvenile pallid, lake and associated with notched L-dikes may be important habitat for juvenile sturgeon of all species.

Young of year paddlefish collected at Overton Bottoms



Series of L-dikes at Overton Bottoms which produced unusually high catches of sturgeon and paddlefish

Table 3. Total catch (TC) and percent relative abundance (RA) of each species collected by trawl samples on the Lower Missouri River in 2002.

SITE	St.Charles		Hermann		Hartsburg		Plowboy		Overton		Lisbon		TOTAL	
RIVER MILES	20-30		95-105		156-166		170-180		180-190		210-220			
Species	TC	RA	TC	RA	TC	RA	TC	RA	TC	RA	TC	RA	TC	RA
Lake sturgeon	1	0.1							3	0.1			4	T
Pallid sturgeon									1	T	4	0.1	5	T
Pallid hybrid	2	0.2			1	0.2							3	T
Shovelnose sturgeon	39	4.6	65	4.7	13	2.7	67	2.4	104	2.9	91	2.8	379	3
Unidentified sturgeon									13	0.3	2	0.1	15	0.1
Paddlefish									7	0.2			7	0.1
Longnose gar			1	0.1					1	T	1	T	3	T
Shortnose gar									9	0.2	8	0.3	17	0.1
Goldeye	5	0.6	16	1.2	3	0.6	52	1.8	172	4.4	262	8.2	510	4
Skipjack herring			14	1.1									14	0.1
Gizzard shad	5	0.6					6	0.2	1	T	133	4.1	145	1.2
Goldfish			1	0.1					1	T			2	T
Red shiner					1	0.2	75	2.7	47	1.2	24	0.8	147	1.2
Common carp	2	0.2	2	0.1	2	0.4	2	0.1	9	0.2	8	0.3	25	0.2
Hybognathus spp.							2	0.1			1	T	3	T
Bighead carp									2	0.1			2	T
Speckled chub	23	2.7	8	0.6	12	2.5	167	5.9	501	12.9	92	2.9	803	6.4
Sturgeon chub	3	0.4			3	0.6	36	1.3	35	0.9	8	0.3	85	0.7
Sicklefin chub			9	0.7	44	9.1	325	11.5	432	11.1	259	8.1	1069	8.5
Silver chub	4	0.5	7	0.5	19	3.9	25	0.9	99	2.6	94	2.9	248	2
Unid. Chub	2	0.2					3	0.1	35	0.9	16	0.5	56	0.4
Emerald shiner	1	0.1			2	0.4	70	2.5	249	6.4	75	2.3	397	3.1
River shiner											1	T	1	T
Ghost Shiner									2	0.1			2	T
Sand shiner							1	T	1	T	1	T	3	T
Channnel shiner	1	0.1	1	0.1									2	T
Bluntnose minnow									1	T			1	T
Bullhead minnow			6	0.4					5	0.1	1	T	12	0.1
River carpsucker	10	1.2	12	0.9	53	11	57	2	85	2.2	7	0.2	224	1.8
Blue sucker	4	0.5	2	0.1	1	0.2	1	T	7	0.2	4	0.1	19	0.2
Smallmouth buffalo			1	0.1	2	0.4			1	T			4	T
Bigmouth buff.									1	T	1	T	2	T
Shorthead red.	3	0.4									1	T	4	T
Blue catfish	195	22.9	96	6.9	58	12	343	12.1	278	7.2	113	3.5	1083	8.6
Channel catfish	433	50.8	591	42.5	192	39.8	1051	37.2	1196	30.8	161	5	3624	28.7
Flathead catfish	2	0.2	2	0.1			6	0.2	11	0.3	1	T	22	0.2
White bass	37	4.3	19	1.4			1	T	2	0.1	15	0.5	74	0.6
Green sunfish											1	T	1	T
Orangespotted sun.	2	0.2											2	T
White crappie							2	0.1	8	0.2	3	0.1	13	0.1
Black crappie									2	0.1			2	T
Sauger	2	0.2	1	0.1	1	0.2			4	0.1	7	0.2	15	0.1
Walleye									1	T		0	1	T
Freshwater drum	75	8.8	538	38.7	74	15.4	485	17.2	494	12.7	1806	56.3	3472	27.5
Unidentified Fish	1	0.1			1	0.2	49	1.7	64	1.7	8	0.3	18	0.1
TOTAL	747		1247		326		1937		2060		2115		12645	

T=Trace number of fish (i.e. 1 or 2)

Trawls were effective at collecting all sizes of sturgeon ranging from 17 mm to 704 mm fork length (Figure 4). It may be possible to assign approximate age and year class to length frequency distributions in the future using age and growth data currently being developed by MDC. However, this technique will likely be useful for young fish only, since older fish grow at differing rates and tend toward clumping and overlap in this kind of analysis.

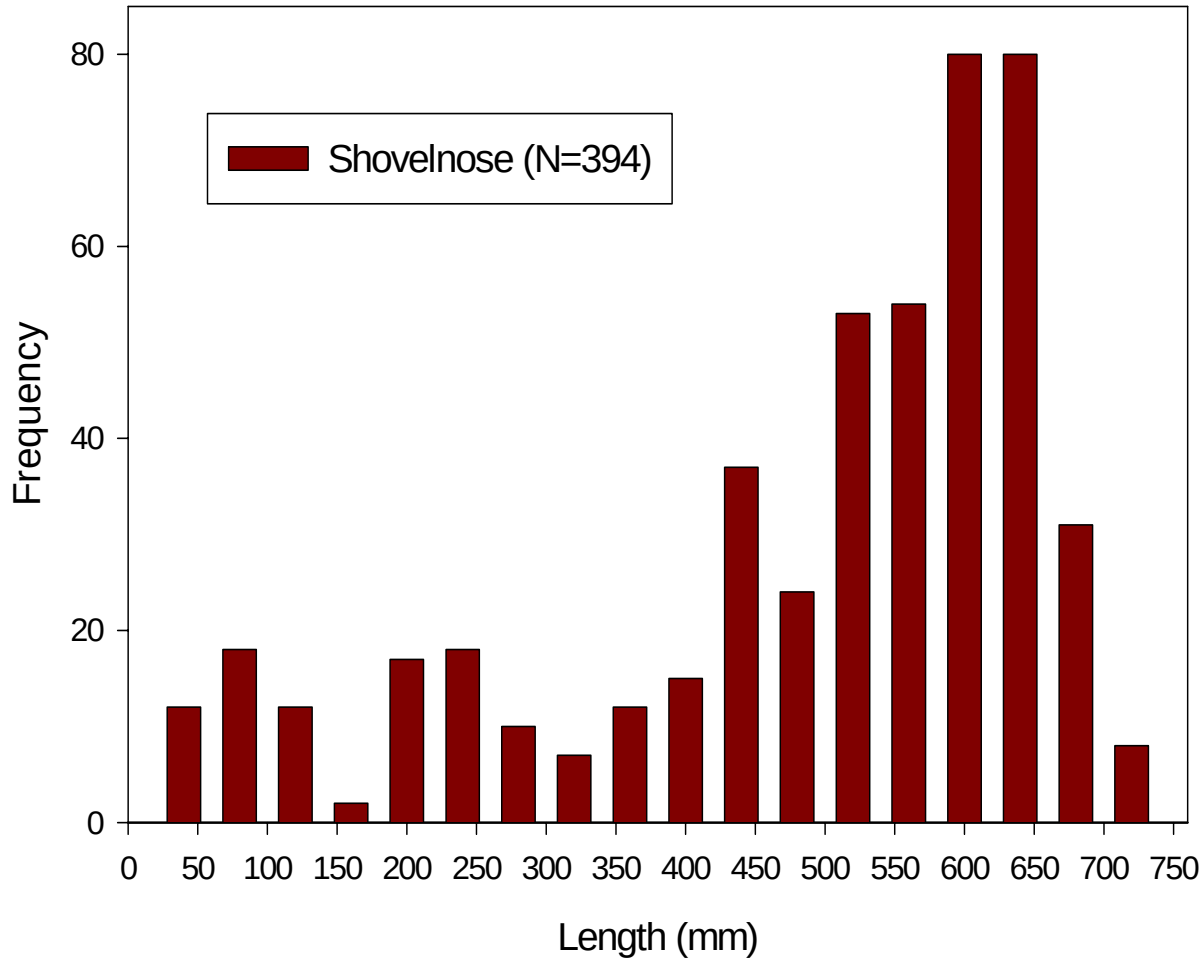


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Figure 4. Length frequencies of shovelnose sturgeon caught in trawls in the Lower Missouri River from June to October 2002.

A diversity of habitats were sampled in an effort to include all possible pallid sturgeon habitat. Bramblett (1996) reported that pallid sturgeon preferred sandy substrate associated with alluvial sandbars. More sturgeon were collected per trawl in sandbar habitat associated with sandy substrate than all other habitat types sampled (Figure 5). Figure 5 shows the percentage of shovelnose captured relative to the percentage of total habitat type sampled by area ($100m^2$) and by percentage of total trawl hauls. Juvenile sturgeon (<300mm) were strongly associated with main channel sand bars over sand substrate (Figure 6).

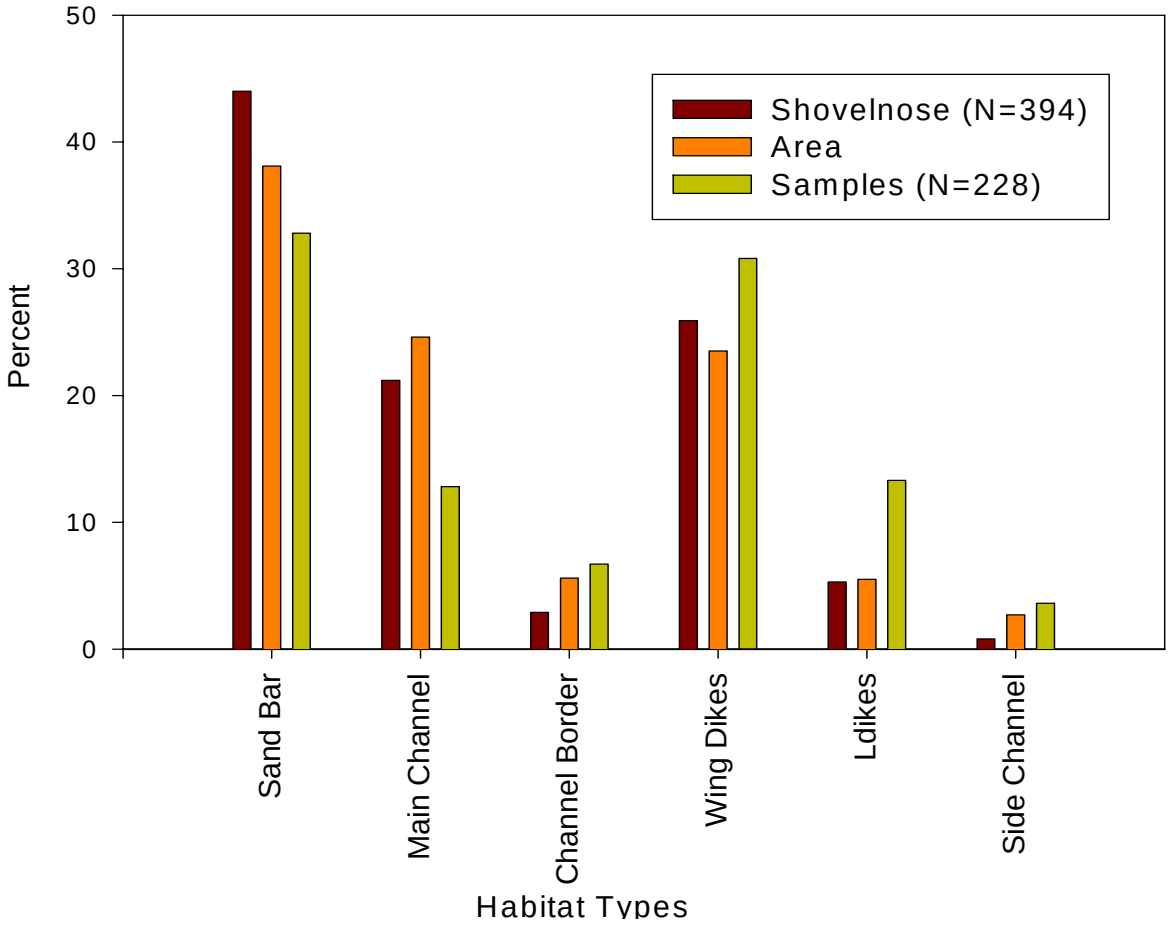
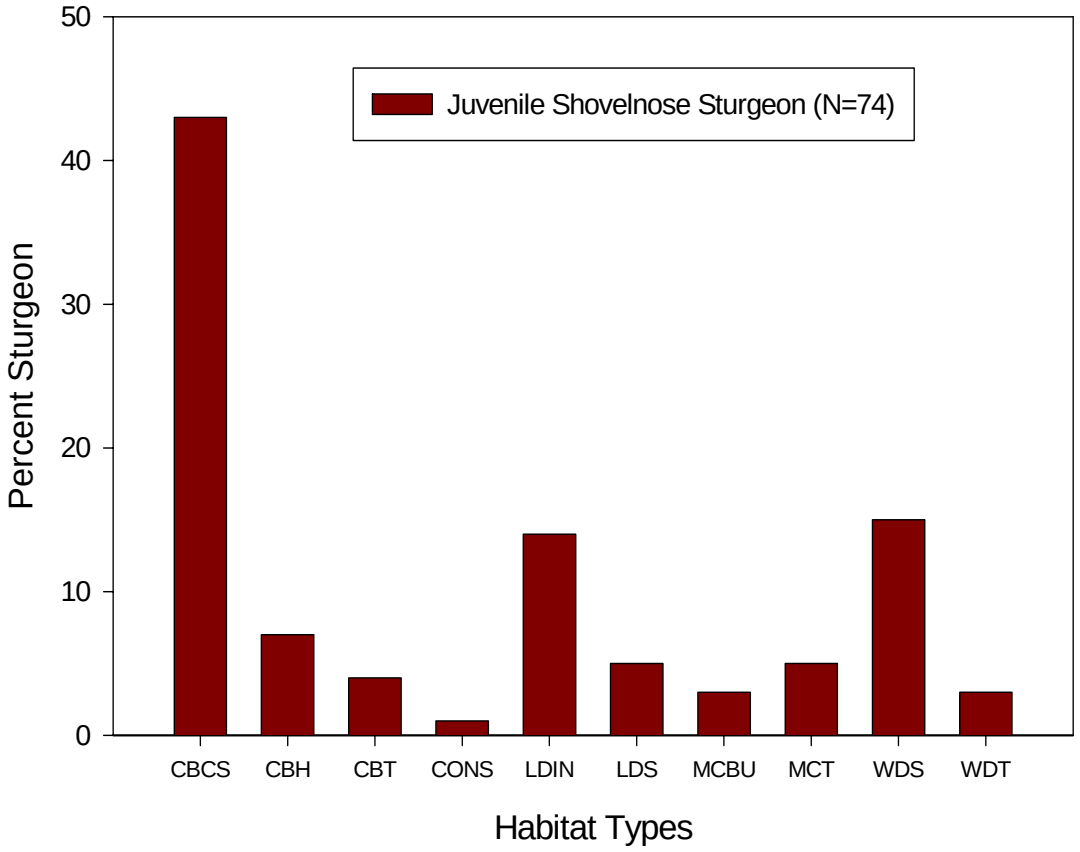


Figure 5. Percentage of shovelnose sturgeon collected in trawls among different habitat types in the Lower Missouri River in 2002.



CBCS-Channel Bar Channel Side	LDS- L-dike Sand Bar
CBH- Channel Bar Head	MCBU-Main Channel Border Unstructured
CBT- Channel Bar Tail	MCT- Main Channel Trough
CONS-Connected Sand Bar	WDS- Wing Dam Sandbar
LDIN- Inside of Notched L-dike	WDT- Wing Dam Tip

Figure 6. Percentage of juvenile shovelnose sturgeon collected with trawls in the Lower Missouri River from June to October, 2002 by habitat type.

Example of a channel bar with a channel side (left) and bank side habitat (right)(RM 216)

Additional habitats in which sturgeon were often found were sandbars behind or downstream of wing-dikes and along the inside of notched L-dikes on sand bars where there was moderate flow.

Typical wing-dike habitat with a scour hole downstream associated with a sand bar

Example of a deep notch on an L-dike that allows scouring flows at normal water stages

Relationships between shovelnose sturgeon CPUE and velocity, depth, turbidity and DO were analyzed using linear regression analysis. No significant relationships were found. Sampling design and difficulty in quantifying distinct habitat parameters for each trawl made statistical analysis difficult. Shovelnose sturgeon preferred areas with moderate to high velocity >0.3 m/s (Figure 7). Juvenile sturgeon, <300mm fork length, were caught throughout the range of velocities sampled. However, two-thirds were caught between 0.3 and 0.8 m/s (Figure 8). Increased catch coupled with decreased sampling effort in Figures 7 and 8 show higher CPUE at a specified velocity range.

A juvenile lake (top) and shovelnose sturgeon (bottom) captured in an otter trawl along a sand bar tip

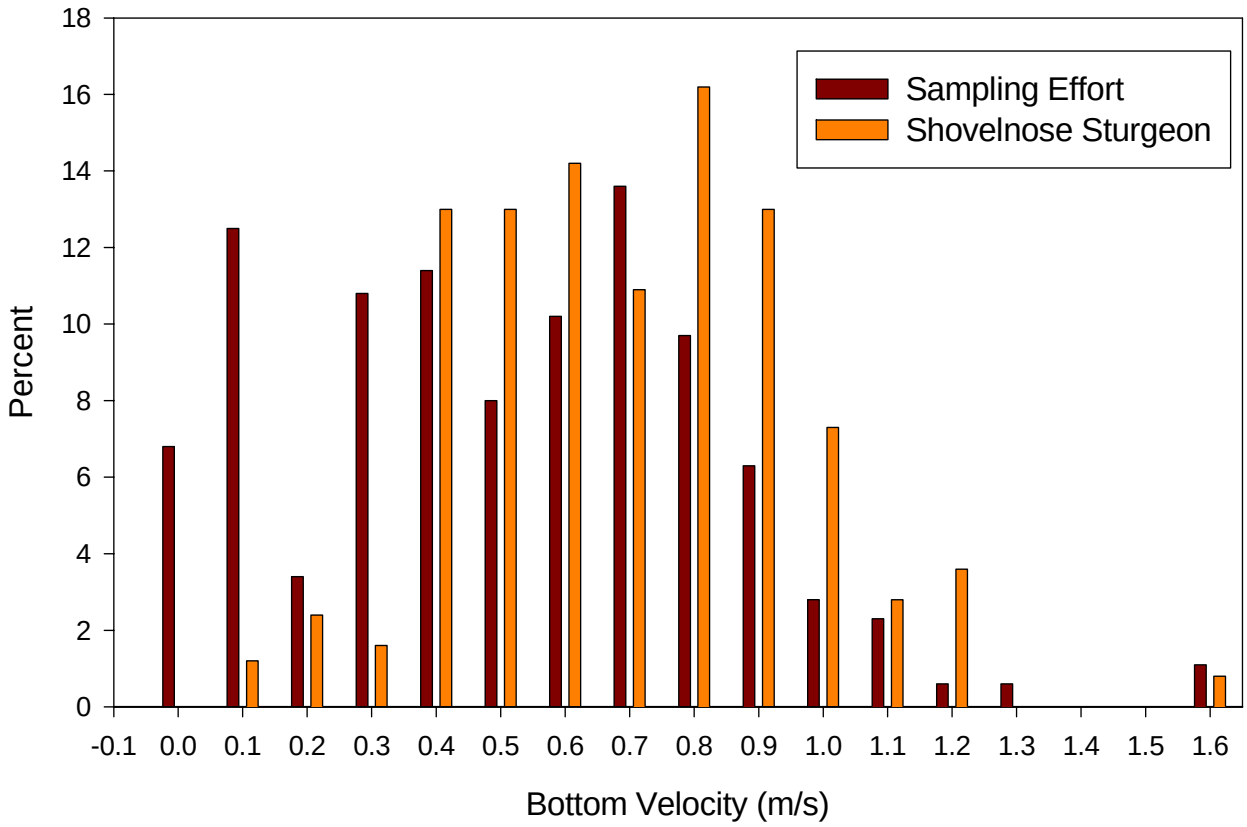


Figure 7. Percent shovelnose caught by trawl in relation to velocities and percent total sampling effort in the Lower Missouri River from June to October, 2002.

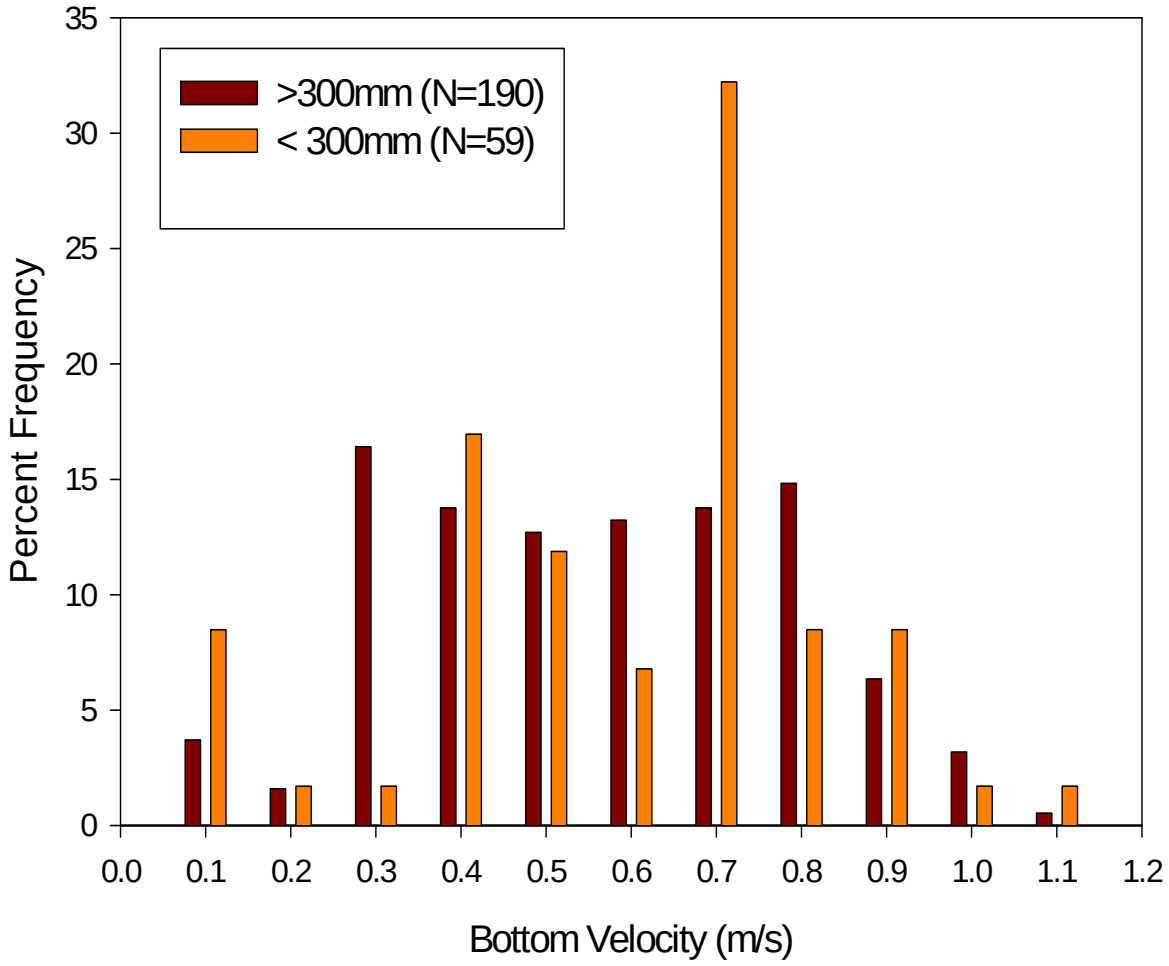


Figure 8. Adult and juvenile shovelnose sturgeon captured by trawl in a range of current velocities in the Lower Missouri River from June to October, 2002.

Three otter trawl types were evaluated to determine the efficacy of different nets in catching different sizes and numbers of fish. The net types were: a 16 foot wide; 1 ½ inch stretch outer body mesh with ¾ inch stretch bag and 1/8 inch bag liner: a 22 foot wide; 1 ½ inch stretch outer body mesh with 5/8 inch stretch bag and ¼ inch bag liner: 22 foot wide; 3.0 inch stretch outer body mesh with 1 ½ inch stretch body and ¼ inch bag liner. All three otter trawls captured sturgeon over a range of sizes. The larger mesh (3.0 inch) was more efficient at capturing larger sturgeon but was not as effective in catching smaller sturgeon (Figure 9). The 16 and 22 foot trawls with 1 ½ inch stretch mesh caught sturgeon and benthic fishes of similar sizes. The size of the inner bag liner did not appear to be a factor, since it was often clogged with debris.

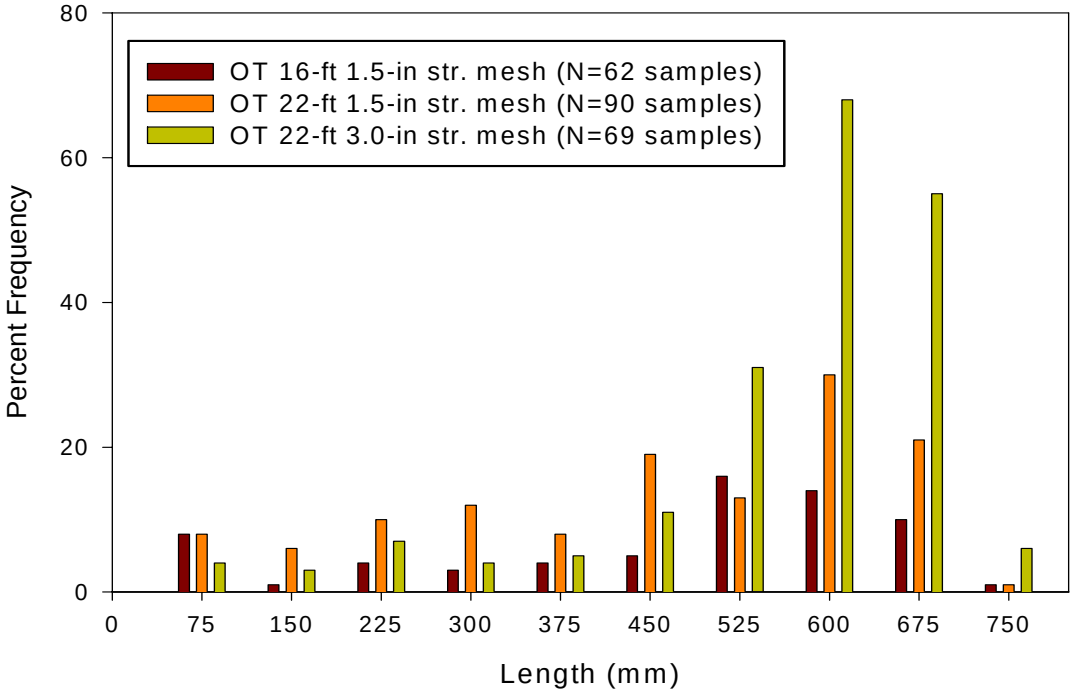


Figure 9. Sampling efficiency of three otter-trawl sizes used to capture shovelnose sturgeon in the Lower Missouri River from June to October 2002.

Stern trawls were used in June and July at Overton and Lisbon and bow trawling was used for all other samples. Trawls could be deployed and retrieved quickly from the stern trawler minimizing fish escape and allowing the crew to take small distinct samples behind dike structures or along dike sand bars. Bow trawls could not effectively sample behind wing dikes where many sturgeon were found, because the net often rolled or the otter boards twisted preventing the mouth of the net from fully opening at deeper depths. Some sand bar habitats were not sampled often with the bow trawler because of the effort and time it took to deploy and retrieve the net by hand. Bow trawls could be used effectively in long unobstructed habitats such as channel bars and channel troughs. Results between sites may reflect the sampling efficiency of these two methods or seasonal differences between summer and fall (Appendix A).

Seines

Seines captured 8261 fish representing 35 species. The most abundant species were river carpsuckers at 45 percent of the sample, followed by emerald shiners at 23 percent and red shiners at 19 percent of the sample (Table 4). Table 5 shows combined CPUE among all reaches for each habitat type sampled. The highest catch rates among habitat types were at L-dikes where catch per unit effort (CPUE) = 18.21 fish/10m^2; followed by sand bars within side channels CPUE = 15.35 and bank side of main channel sand bars where CPUE = 12.54 (Table 5). These habitats were important to native species as nursery and rearing habitat. CPUE was likely higher in these areas because they serve as functional backwater habitat for small fishes under normal to low flow conditions. Unequal effort between reaches or abnormally high catches of one species may explain the differences seen in total catch between reaches. Likewise, the difference could be due to differences in available habitat, but more data is needed to determine if this is the case.

Table 4. Total catch (TC) and percent relative abundance (RA) of each species collected by seine on the Lower Missouri River in 2002.

SITE RIVER MILE	St. Charles 20-30		Hermann 95-105		Plowboy 170-180		Overton 180-190		Lisbon 210-220		TOTAL	
SPECIES	TC	RA	TC	RA	TC	RA	TC	RA	TC	RA	TC	RA
Shortnose gar	1	0.1					6	0.2	7	0.4	14	0.2
Goldeye			5	0.6	14	0.7	19	0.7	2	0.1	40	0.5
Gizzard shad	63	8.6	10	1.2	5	0.2	67	2.6	48	2.5	193	2.3
Central stoneroller	1	0.1					7	0.3	23	1.2	31	0.4
Red shiner	297	40.6	55	6.5	254	11.9	261	10.0	701	36.3	1568	19.0
Common carp							4	0.2	14	0.7	18	0.2
Western silvery minnow					1	T					1	T
Hybognathus spp.					1	T	11	0.4	16	0.8	28	0.3
Plains minnow			1	0.1			14	0.5	8	0.4	23	0.3
Redfin shiner									1	0.1	1	T
Speckled chub	2	0.3	2	0.2			3	0.1	13	0.7	20	0.2
Sicklefin chub									3	0.2	3	T
Silver chub					6	0.3	19	0.7	23	1.2	48	0.6
Unidentified chubs							3	0.1			3	T
Emerald shiner	252	34.4	262	30.9	687	32.1	195	7.5	480	24.8	1876	22.7
River shiner							2	0.1	12	0.6	14	0.2
Bigmouth shiner									10	0.5	10	0.1
Sand shiner	14	1.9	3	0.4	17	0.8	15	0.6	76	3.9	125	1.5
Channel shiner	3	0.4									3	T
Suckermouth minnow			1	0.1			10	0.4	13	0.7	24	0.3
Bluntnose minnow							4	0.2	14	0.7	18	0.2
Fathead minnow							22	0.8	5	0.3	27	0.3
Bullhead minnow	5	0.7					12	0.5	28	1.5	45	0.5
River carpsucker	88	12.	415	48.9	1116	52.2	1763	67.6	370	19.1	3752	45.4
Smallmouth buffalo							2	0.1			2	T
Bigmouth buffalo							7	0.3	1	0.1	8	0.1
Channel catfish	4	0.6	11	1.3	26	1.2	8	0.3	4	0.2	53	0.6
Mosquitofish							3	0.1	1	0.1	4	0.1
White bass	2	0.3	17	2.0	5	0.2	18	0.7	12	0.6	54	0.7
Orangespotted sunfish							10	0.4			10	0.1
Bluegill							36	1.4			36	0.4
Largemouth bass							5	0.2	4	0.2	9	0.1
White crappie							17	0.7	4	0.2	21	0.3
Black crappie							10	0.4			10	0.1
Freshwater drum			2	0.2	5	0.2	25	1.0	23	1.2	55	0.7
Unidentified fish					3	0.1	27	1.0	13	0.7	43	0.5
TOTAL	732		848		2140		2607		1934		8261	

T = Trace number of fish (i.e. < 0.1)

Table 5. Catch per unit effort (CPUE) (fish/10m^2) of species captured in seines at selected habitat types on the Lower Missouri River in 2002 (N = number of seine hauls per habitat, SE = standard error).

HABITAT TYPE No. SAMPLES	CBBS (N=11)		CBCS (N=24)		CBH (N=1)		CBT (N=3)		CONS (N=8)		L-DIKE (N=4)		SCB (N=18)		TOTAL (N=70)	
SPECIES	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
Shortnose gar			T				T		T		T		T		T	
Goldeye	T		0.0				T				0.1	0.1	T		T	
Gizzard shad	0.4	0.3	0.3	0.2			0.1	0.1	1.0	0.7	1.0	1.0	0.3	0.2	0.9	0.4
Central stoneroller			0.0										0.1	0.1	T	
Red shiner	1.4	0.4	2.8	0.9	T		0.2	0.1	2.1	0.9	7.8	3.4	8.1	2.6	7.9	4.0
Common carp	0.1	0.1	0.0										T		T	
Hybognathus spp.	0.1	0.1	0.0						T		T		T		T	
Plains minnow	T		T						0.1	0.1	T		T		T	
Redfin shiner													T		T	
Speckled chub			0.1	0.1	T		T		T		T		T		T	
Sicklefin chub			0.0												T	
Silver chub	T										0.4	0.2	T		0.1	0.1
Emerald shiner	0.8	0.3	1.1	0.3	0.1	.	1.3	0.4	1.3	0.7	7.5	4.7	2.7	1.2	3.6	1.8
River shiner	T		T						T				T		T	
Bigmouth shiner									T				0.1	0.1	T	
Sand shiner	T		0.0				T		T		T		0.4	0.2	0.2	0.1
Channel shiner			T												T	
Suckermouth minnnow	T		T								T		T		T	
Bluntnose minnow									T				0.1	0.1	T	
Fathead minnow	T												T		T	
Bullhead minnow			T				0.1	0.1			T		0.2	0.1	0.1	0.1
River carpsucker	9.4	9.3	1.4	0.7	T		0.6	0.4	0.4	0.2	T		2.6	1.4	5.3	3.0
Smallmouth buffalo	T														T	
Bigmouth buffalo	T		T												T	
Channel catfish	T		T		T		T		T		0.1	0.1	T		T	
Mosquitofish	T												T		T	
White bass	T		T						T		T		T		T	
Orangespotted sun.													T		T	
Bluegill													0.1	0.1	T	
Largemouth bass											T		T		T	
White crappie			T								T		T		T	
Black crappie													T		T	
Freshwater drum	T		T				T		T		0.5	0.5	0.1	0.1	0.1	0.1
Unidentified fish	T		T						T		T		0.2	0.2	0.1	0.1
TOTAL	12.5	9.2	5.9	1.1	0.3	.	2.6	0.5	5.1	1.6	18.2	2.5	15.3	3.6	19.2	9.6

T=Trace number of fish (i.e. < 0.1)

CBBS - Main channel bar bank side
CBCS - Main channel bar channel side
CBH - Main channel bar head
CBT - Main channel bar tail
CONS - Connected sand bar
L-dike - Sand bar behind dike
SCB - Side channel bar

CPUE by sampling reach was highest at Overton Bottoms where CPUE = 14.1 fish/10m^2 and at Lisbon Bottoms where CPUE = 11.1 (Table 6). This may be an artifact of sample size since effort was higher in these areas, however it should be noted that these two reaches have more diverse habitat and ongoing habitat restoration projects.

Table 6. Catch per unit effort (CPUE) (fish/10m^2) for each species caught in seines on the Lower Missouri River in 2002 (N = number of seine hauls per reach, SE = standard error).

SITE	**St. Charles**		**Hermann**		**Plowboy**		**Overton**		**Lisbon**		**TOTAL**	
RIVER MILES	**20-30**		**95-105**		**170-180**		**180-190**		**210-220**			
No. SAMPLES	**N=8**		**N=10**		**N=6**		**N=21**		**N=25**		**N=70**	
SPECIES	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
Shortnose gar	T						T		T		T	
Goldeye			T		T		T		T		T	
Central stoneroller	T						T		0.1	0.1	T	
Gizzard shad	1.2	0.7	0.1	0.1	T		0.6	0.2	0.4	0.2	0.9	0.5
Red shiner	1.8	1	0.2	0.1	1	0.3	5	1.3	6.1	1.9	7.9	4
Common carp							T		T		T	
Hybognathus spp.					T		0.1	0.1	T		T	
Plains minnow			0				T		T		T	
Speckled chub	T		T				T		0.1	0.1	T	
Sicklefin chub	T								T		T	
Silver chub							0.1	0.1	T		0.1	0.1
Unidentifed chub							T				T	
Emerald shiner	1.7	0.4	0.8	0.2	4.7	3.4	1.1	0.3	2.2	0.9	3.6	1.8
Bigmouth shiner							T		T		T	
River shiner							T		T		T	
Channel shiner	T										T	
Sand shiner	T		T		T		T		0.2	0.1	0.2	0.1
Suckermouth min.			T				T		T		T	
Bluntnose minnow							T		T		T	
Fathead minnow							T		T		T	
Bullhead minnow	T						T		0.1	0.1	0.1	0.1
River carpsucker	0.5	0.3	1.3	0.5	0.4	0.3	6.4	4.9	1.4	1	5.3	3
Smallmouth							T				T	
Channel catfish	T		T		T		T		T		T	
Mosquitofish							T		T		T	
White bass	T		T		T		T		T		T	
Orange spotted							T				T	
Bluegill							T				T	
Largemouth bass							T		T		T	
White crappie							T		T		T	
Black crappie							T				T	
Freshwater drum			T		T		0.1	0.1	0.1	0.1	0.1	0.1
Unidentifed fish					T		0.1	0	0.1	0.1	T	
TOTAL	5.4	1.6	2.5	0.6	6.3	3.5	14.1	4.8	11.2	2.8	19.2	9.6

T=Trace number of fish (i.e. < 0.1)

Mini-Fyke Nets

Sampling effort consisted of 55 net nights in three reaches. A total of 3133 fish representing 36 species were captured. As with seines; the most abundant species were red shiners at 26%, emerald shiners at 23% and river carpsuckers at 20% (Table 7). Hermann, St. Charles and Hartsburg reaches were not sampled with mini-fyke nets.

Table 7. Total catch (TC) and percent relative abundance (RA) of fish collected in mini-fyke-net samples on the Lower Missouri River in 2002 (N = number of net days per reach).

SITE	Plowboy		Overton		Lisbon		TOTAL	
RIVER MILES	170-180		170-180		210-220			
No. SAMPLES	N=3		N=12		N=43		N=58	
SPECIES	TC	RA	TC	RA	TC	RA	TC	RA
Longnose gar					2	T	2	T
Shortnose gar			3	0.4	39	1.8	42	1.3
Goldeye			3	0.4			3	0.1
Gizzard shad			2	0.3	24	1.1	26	0.8
Red shiner	65	24.5	260	36.5	502	23.3	827	26.4
Common carp					16	0.7	16	0.5
Hybognathus spp.	1	0.4			3	0.1	4	0.1
Plains minnow			1	0.1	4	0.2	5	0.2
Speckled chub			2	0.3	105	4.9	107	3.4
Sicklefin chub					8	0.4	8	0.3
Silver chub			2	0.3	10	0.5	12	0.4
Unidentified chub			2	0.3	11	0.5	13	0.4
Emerald shiner	113	42.6	86	12.1	534	24.8	733	23.4
River shiner			1	T			1	T
Sand shiner	2	0.8	1	0.1	7	0.3	10	0.3
Suckermouth minnow			1	0.1	1	0.1	2	0.1
Bluntnose minnow			1	0.1	46	2.1	47	1.5
Fathead minnow					4	0.2	4	0.1
Bullhead minnow					48	2.2	48	1.5
River carpsucker	1	0.4	242	33.9	399	18.5	642	20.5
Bigmouth buffalo					5	0.2	5	0.2
Yellow bullhead					1	0.1	1	T
Channel catfish	2	0.8	14	2	43	2	59	1.8
Flathead catfish					1	T	1	T
Mosquitofish					7	0.3	7	0.2
White bass			1	0.1	40	1.9	41	1.3
Striped bass					1	T	1	T
Green sunfish			15	2.1	27	1.3	42	1.3
Orangespotted sunfish.					4	0.2	4	0.1
Bluegill			3	0.4	59	2.7	62	1.9
Bluegill X green sunfish.			2	0.3			2	0.1
Largemouth bass			2	0.3			2	0.1
White crappie					11	0.5	11	0.3
Black crappie					5	0.2	5	0.2
Sauger					1	T	1	T
Freshwater drum	1	0.4	64	9	101	4.7	166	5.3
Unidentifed fish	80	30.2	5	0.7	86	4	171	5.5
TOTAL	265		713		2155		3133	

T=Trace number of fish (i.e. < 0.1)

Catch rates (CPUE) in mini-fyke nets was similar between the Lisbon (CPUE = 109.02 fish/net-day) and Overton (CPUE = 96.97 fish/net-day) reaches (Table 8). CPUE was higher in backwater habitat (BWC) than in all others, but relatively few species were captured there compared to other habitats (Table 9). Backwater habitats were waters that had no flow such as a pool or non-connected side channel. Missing data at Plowboy Bend (N=3) did not allow for CPUE calculations.

Table 8. Catch per unit effort (CPUE) (fish/net day) of fish collected in mini-fyke nets at two sample reaches on the Lower Missouri River in 2002 (N = number of fyke nets per reach, SE = standard error).

SITE	OVERTON		LISBON		TOTAL	
RIVER MILES	180-190		210-220			
No. SAMPLES	N=12		N=43		N= 55	
Species	CPUE	SE	CPUE	SE	CPUE	SE
Longnose gar			T		T	
Shortnose gar	0.2	0.1	0.9	0.3	0.8	0.3
Goldeye	0.3	0.2			T	
Gizzard shad	0.2	0.1	0.6	0.2	0.5	0.2
Red shiner	20.9	5.9	38.4	9.9	34.6	7.9
Common carp			0.5	0.2	0.4	0.2
Hybognathus spp.			0.1	0.1	T	
Plains minnow	0.1	0.1	0.1	0.1	0.1	0.1
Speckled chub	0.1	0.1	2.4	0.9	1.9	0.7
Sicklefin chub			0.3	0.2	0.2	0.1
Silver chub	0.2	0.2	0.3	0.1	0.3	0.1
Unidentifed chub	0.2	0.2	1.2	1.1	1	0.9
Emerald shinner	8.8	6	26.1	6.3	22.3	5.1
River shiner	0.1	0.1			T	
Sand shiner	0.1	0.1	0.2	0.1	0.1	0.1
Suckermouth minnow	0.1	0.1	T		T	
Bluntnose minnow			1.1	0.3	0.8	0.2
Fathead minnow			0.1		T	
Bullhead minnow			1.3	0.4	1	0.3
River carpsucker	57.5	32.1	19.9	8.4	28.1	9.7
Bigmouth buffalo			0.1	0.1	0.1	0.1
Yellow bullhead			T		T	
Channel catfish	0.9	0.5	1	0.2	1	0.2
Flathead catfish			T		T	
Mosquitofish			0.2	0.1	0.1	0.1
White bass			0.9	0.4	0.7	0.3
Striped bass			T		T	
Green sunfish	1.3	0.5	0.6	0.2	0.8	0.2
Orange spotted			0.1	0.1	0.1	0.1
Bluegill	0.2	0.2	1.5	0.5	1.2	0.4
Bluegill X green	0.2	0.1			T	
Largemouth bass	0.1	0.1			0	
White crappie			0.2	0.1	0.2	0.1
Black crappie			0.1	0.1	0.1	0.1
Sauger			T		T	
Freshwater drum	4.7	2.3	2.5	0.8	3	0.8
Unidentifed fish	1.1	0.7	8.3	4.1	6.7	3.2
TOTAL	97	31.4	109	24.6	106.4	20.3

T=Trace number of fish (i.e. <0.1)

Table 9. Catch per unit effort (CPUE) (fish/net-day) by species captured with mini-fyke nets in six habitat types sampled on the Lower Missouri River in 2002 (N = number of fyke nets per habitat type, SE = standard error).

HABITAT TYPE NUMBER SAMPLES	BWC N=2		CBBS N=12		CBCS N=13		CBH N=3		CONS N=6		SCB N=19		TOTAL N=55	
SPECIES	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
Longnose gar											0.1	0.1	0.0	0.0
Shortnose gar	0.5	0.5	0.4	0.2	0.5	0.3					1.6	0.7	0.8	0.3
Goldeye	1.0	1.0			0.1	0.1							0.1	0.0
Gizzard shad			0.4	0.4	0.1	0.1	0.4	0.4	0.5	0.2	0.9	0.5	0.5	0.2
Red shiner	27.1	11.8	49.0	19.5	55.1	26.7	39.3	18.1	20.2	8.4	16.1	3.9	34.6	7.9
Common carp			0.3	0.2							0.9	0.4	0.4	0.2
Hybognathus spp			0.2	0.2	0.1	0.1							0.1	0.0
Plains minnow			0.1	0.1					0.2	0.2	0.2	0.2	0.1	0.1
Speckled chub			1.1	0.5	1.2	0.7			1.0	0.6	3.7	2.0	1.9	0.7
Sicklefin chub			0.1	0.1	0.7	0.5			0.3	0.2			0.2	0.1
Silver chub			0.2	0.1	0.5	0.4					0.3	0.2	0.3	0.1
Unidentified chub									8.6	7.7	0.1	0.1	1.0	0.9
Emerald shiner	5.1	5.1	41.2	17.8	26.1	9.2	25.7	19.0	4.2	2.2	14.7	5.9	22.3	5.1
River shiner							0.3	0.3					0.0	0.0
Sand shiner			0.3	0.4	0.3	0.1							0.1	0.1
Suckermouth min.	0.5	0.5									0.1	0.1	0.0	0.0
Bluntnose minnow			1.5	0.7	1.2	0.5			1.1	1.1	0.3	0.1	0.8	0.2
Fathead minnow			0.2	0.1							0.0	0.1	0.1	0.0
Bullhead minnow			1.3	0.9	0.6	0.3			0.2	0.2	1.7	0.6	1.0	0.3
River carpsucker	197.4	193.4	49.1	28.7	11.3	2.9	1.3	0.8	49.3	17.6	6.0	3.1	28.1	9.7
Bigmouth buffalo					0.1	0.1					0.2	0.1	0.1	0.1
Yellow bullhead									0.2	0.2			0.0	0.0
Channel catfish	1.5	1.5	0.9	0.4	1.4	0.5	0.3	0.3	2.0	1.0	0.6	0.3	1.0	0.2
Flathead catfish											0.1	0.1	0.0	0.0
Mosquito fish					0.2	0.2					0.2	0.1	0.1	0.1
White bass			0.8	0.5	1.6	1.3			0.5	0.3	0.3	0.2	0.7	0.3
Striped bass			0.1	0.1									0.0	0.0
Green sunfish	1.5	0.5	0.8	0.5	0.6	0.3	3.4	1.2	1.5	1.1	0.2	0.1	0.8	0.2
Orangespotted sun.			0.3	0.3									0.1	0.1
Bluegill	1.0	1.0	1.3	0.8	1.1	0.7			3.8	2.7	0.6	0.3	1.2	0.4
Bluegill X green sun.	0.5	0.5							0.2	0.2			0.0	0.0
Largemouth bass	0.5	0.5											0.0	0.0
White crappie			0.1	0.1	0.2	0.2					0.4	0.1	0.2	0.1
Black crappie					0.3	0.3					0.1	0.1	0.1	0.1
Sauger											0.0	0.1	0.0	0.0
Freshwater drum	3.6	0.5	3.8	2.3	5.6	2.1	1.0	0.6	1.0	0.5	1.6	0.8	3.0	0.8
Unidentified fish			7.7	7.4	6.3	3.1			29.8	24.4	0.8	0.3	6.7	3.2
TOTAL	240.3	177.9	161.4	72.0	115.0	37.6	71.7	34.4	124.6	48.6	51.4	10.6	106.4	20.3

T=Trace number of fish (i.e. 1,2 or 3)
BWC – Backwater connected to river
CBBS – Main channel bar bank side
CBCS – Main channel bar channel side
CBH - Main channel bar head
CONS - Connected sand bar
SCB - Side channel bar

Discussion

Monitoring efforts in 2002 indicate that pallid sturgeon continue to decline relative to all river sturgeon. Almost twice as many pallid sturgeon were collected in 2002 samples, compared to 2001, providing important data about habitat associations, movement and growth. Adult pallid sturgeon were captured in gillnets only and the sample size was too small to determine preferences for depth, substrate or velocities. Juvenile pallid sturgeon were captured in trawls and found to be strongly associated with island tip habitat. Juvenile shovelnose were also found in this habitat and co-occurred with pallids in most of the samples. Young of year sturgeon were found along channel sand bars where they have been found in the past, but they were also found behind notched dikes with moderate flows. In addition to sand bars, there appears to be preferred habitat created by dike modifications or islands which is used by pallids, lakes and shovelnose sturgeon in the early stages of life. These areas may be important to identify and restore or create to support long term recovery and maintenance of sturgeon populations.

Many habitat components of the river environment could not be sampled due to high velocities, gear limitations and safety concerns. Pallid sturgeon may be inhabiting areas inaccessible to available gear. For example, one pallid sturgeon was captured on an outside bend revetment in a trawl sample. Revetment habitat was sampled numerous times in 2002, but much of it is now deemed too dangerous for trawling. Channel bars, although very productive for sturgeon are sometimes so riddled with snags that trawling is impossible. These areas may be providing important habitat, but trawling has not worked well due to snagging and consequent equipment damage and losses. Further experimentation with other gear and methods is needed to develop sampling techniques for these habitats.

Two trawling techniques were used this year; stern trawling and bow trawling. The stern trawling boat has a hydraulic winch and large deck that allows for quick deployment followed by fast retrieval of the net. This allows for sampling smaller macro-habitat units in less time with minimal loss of fish during net-retrieval. In comparison, bow trawling is all done manually. This takes much more time and makes short trawls impractical. Several sizes of trawl nets were evaluated to determine the most efficient net for all sizes of fish. Three types of otter-trawl nets were used randomly in different habitats throughout the year. Sampling data suggests that a 16 foot, 1.5 inch bar stretch mesh slingshot balloon trawl was effective in collecting all sizes of fish including young of year and juvenile sturgeon. The beam trawl with a 1/8 inch mesh inner liner was found to be far less effective than the otter trawls with 3 inch and 1 ½ inch mesh. It is likely that the beam trawl would be more effective if a larger mesh inner liner was used. When the mesh is too small the water creates a hydraulic head at the mouth and forces fish out. Beam trawl net designs are being tested by Nebraska Game and Parks Commission and will be incorporated in 2003 sampling.

Young of year sturgeon, juvenile sturgeon and pallid sturgeon were collected with trawls on sand bars, island tips and notched L-dikes. Shovelnose sturgeon CPUE increased when water velocities were above 0.4 m/s and below 1.2 m/s. Trawl sampling in 2003 should be expanded to include multiple samples at various depths within habitat types to determine if there are preferred depths or velocities within the habitat and evaluate how those depth and velocity preferences may change seasonally.

Overton Bottoms produced good catches of shovelnose, lake and pallid sturgeon. Data from community sampling suggests the area is also highly productive for other riverine species. In recent years, numerous dikes have been modified by notching and several rootless dikes created. Rootless dikes are not connected to the bank and by design erode away the bank creating deep scour holes and a more diverse habitat behind the dike. Other modifications include the deepening and widening of notches to allow more flow than traditional smaller notches, this creates deeper scours and erodes silt deposits to expose sandy substrate. Modified dikes have produced catches of over 100 sturgeon per net day and appear to be successful habitat improvements. Other notable dike modifications were at Plowboy (RM 170-180) and Hermann (RM 95-105) where reverse dikes were constructed. Reverse dikes direct water flow towards the bank instead of diverting the water towards the channel. Numerous juvenile and adult shovelnose sturgeon were collected on gravel bars associated with these structures.

Lisbon was the only reach sampled where a large expanse of sand bars had formed below an island. Numerous sturgeon including 3 pallids were collected here. Other islands at Hermann and Overton do not have sand bars below them and were not productive for sturgeon. Island tips with extensive sand bars are rare in the Lower Missouri and may be an important component of the pallid sturgeon habitat requirements. St. Charles was the only reach sampled which had older existing rootless dikes that perform similar to islands by allowing water to flow around both sides thereby creating diverse flows, substrate and depths. These dikes held more sturgeon than typical channel sand bars within the same reach. St. Charles had fewer wing dikes with deep holes than found in other reaches. At higher water levels these dikes may be as productive as others, but in 2002 water levels were very low and deep scours were not abundant. The 2002 winter gillnet data showed that catch rates increased in deeper holes among all reaches. Low catches of all species in gillnets at the St. Charles reach may be a function of availability of scour holes at low flows.

Monitoring is producing better information on status and trends in pallid and other sturgeon populations as well as associated fish communities. Increased numbers of pallids resulting from increased hatchery propagation and stocking improves the likelihood of capturing pallid sturgeon and gaining new insight to habitat use and life history requirements. Recaptures of tagged wild and hatchery fish provide new information on growth, movement and habitat preferences. New and improved trawling methods are providing better information on juvenile sturgeon distribution, abundance and habitat use. As the long term monitoring program is developed and implemented, it will produce new information and insight critical to habitat restoration, flow management and pallid sturgeon recovery as well as a healthier, self-sustaining Missouri River aquatic ecosystem.

Acknowledgments

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Literature Cited

Bramblett, R. G. 1996. Habitats and movements of pallid and shovelnose sturgeon in the Yellowstone and Missouri Rivers, Montana and North Dakota. Doctoral dissertation. Montana State University - Bozeman, Montana.

Drobish, M., J. Milligan, C. Gemming, G. Mestl, L. Miller and K. Tjelmeland. 2001. Pallid Sturgeon Population and Habitat Monitoring Plan for the Missouri and Kansas Rivers (DRAFT)

Carlson, D. M. and W. L. Pflieger. 1981. Abundance and life history of the lake, pallid and shovelnose sturgeons in Missouri. Endangered Species Project SE-1-6, Job No. 1. Missouri Department of Conservation, Columbia, Missouri. 63 pp.

Carlson, D. M., W.L. Plieger, L. Trial and P. S. Haverland. 1985. Distribution, biology and hybridization of *Scaphirhynchus albus* and *S. platorynchus* in the Missouri and Mississippi Rivers. Environmental Biology of Fishes 14(1):51-59.

Grady, J. M. 1996. MICRA Mississippi Interstate Cooperative Research Association Inter-jurisdictional Pallid Sturgeon Study Protocol. Columbia FRO, USFWS.

Grady, J. M., J. Milligan, C. Gemming, D. Herzog, G. Mestl, and R. J. Sheehan. 2001. Pallid and shovelnose sturgeons in the Lower Missouri and Middle Mississippi Rivers. Final Report for MICRA.

Krentz, S. 2001. Biological Procedures and Protocol for Collecting, Tagging, Sampling, Holding, Culture, Transporting, and Data Recording for Researchers and Managers Handling Pallid Sturgeon (DRAFT).

National Research Council. 2002. The Missouri River Ecosystem: Exploring the Prospects for Recovery. National Academy Press, Washington, D. C.

Pflieger, W. L. and T. B. Grace. 1987. Changes in the Fish Fauna of the Lower Missouri River, 1940-1983, pp. 166-177. *In:* Community and Evolutionary Ecology of North American Stream Fishes. W. J. Matthews and D. C. Heins (eds.). Univ. of Okla. Press, Norman.

Sheehan, R.J., R.C Heidinger, P.S. Wills, M.A. Schmidt, G.A. Conover, and K.L. Hurley. 1999. Guide to the Pallid Sturgeon Shovelnose Sturgeon Character Index (CI) and Morphometric Character Index (mCI). SIUC Fisheries Bulletin No. 14, Southern Illinois University, Carbondale, Illinois. 16pp.

U.S. Fish and Wildlife Service. 2000. Biological Opinion on the Operation of the Missouri River Main Stem Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System. Fort Snelling, MN.

Appendix A

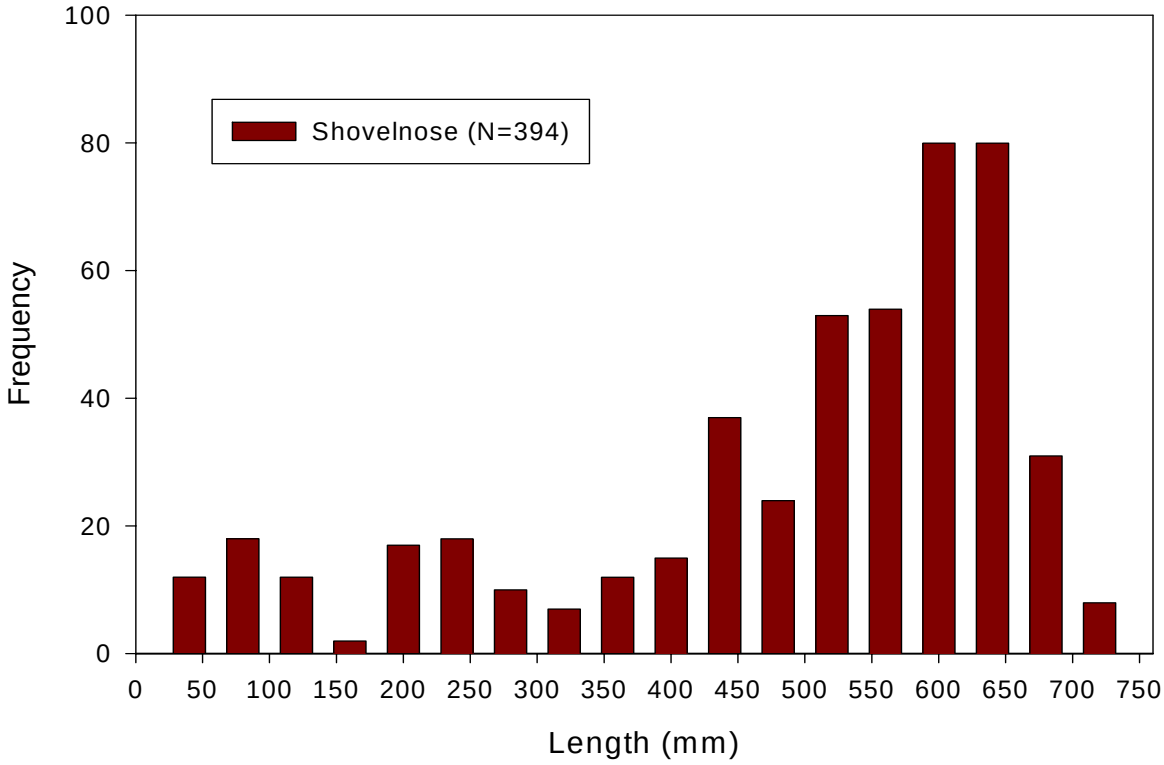

Figure A1. Length frequencies for shovelnose sturgeon caught in trawls from five reaches on the Lower Missouri River.

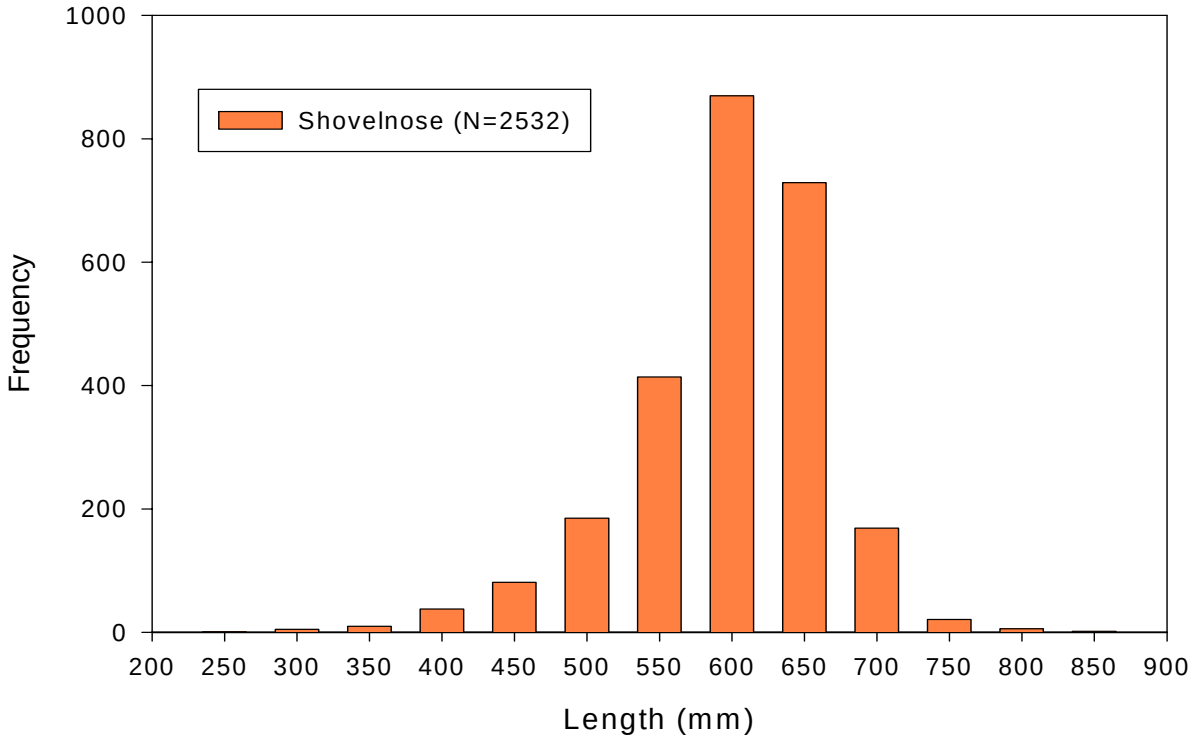

Figure A2. Length frequencies for shovelnose sturgeon caught in gillnets from five reaches on the Lower Missouri River in 2002.

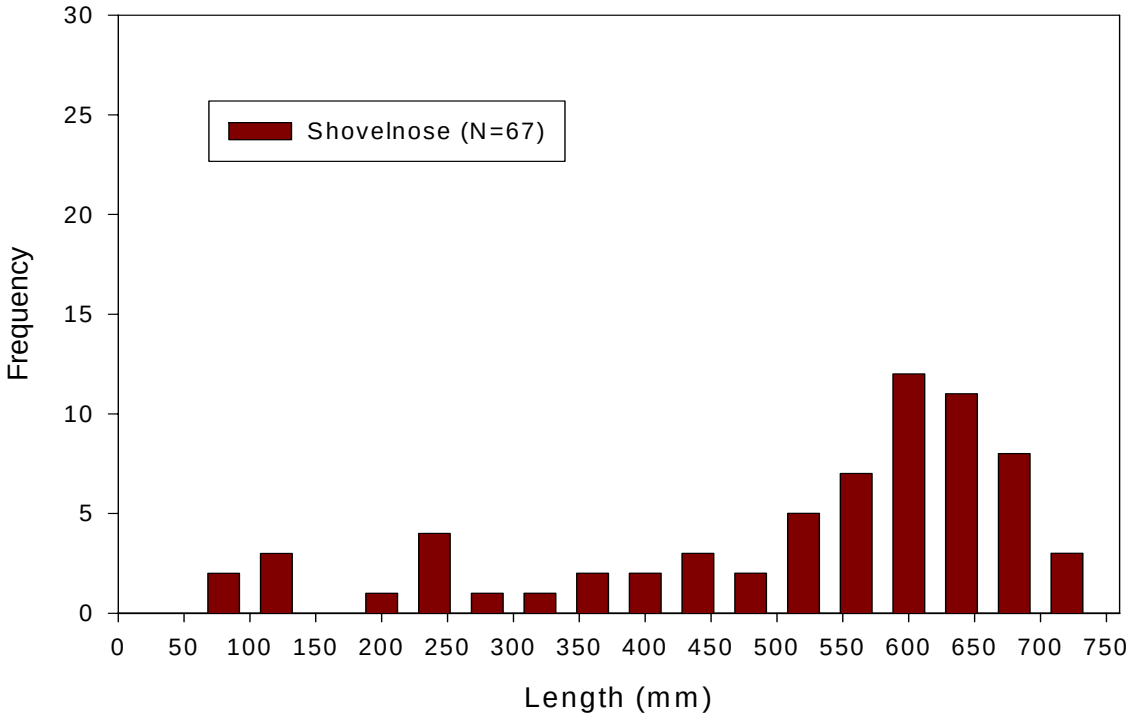

Figure A3. Length frequencies for shovelnose sturgeon captured in trawls at Plowboy Bend on the Lower Missouri River in 2002.

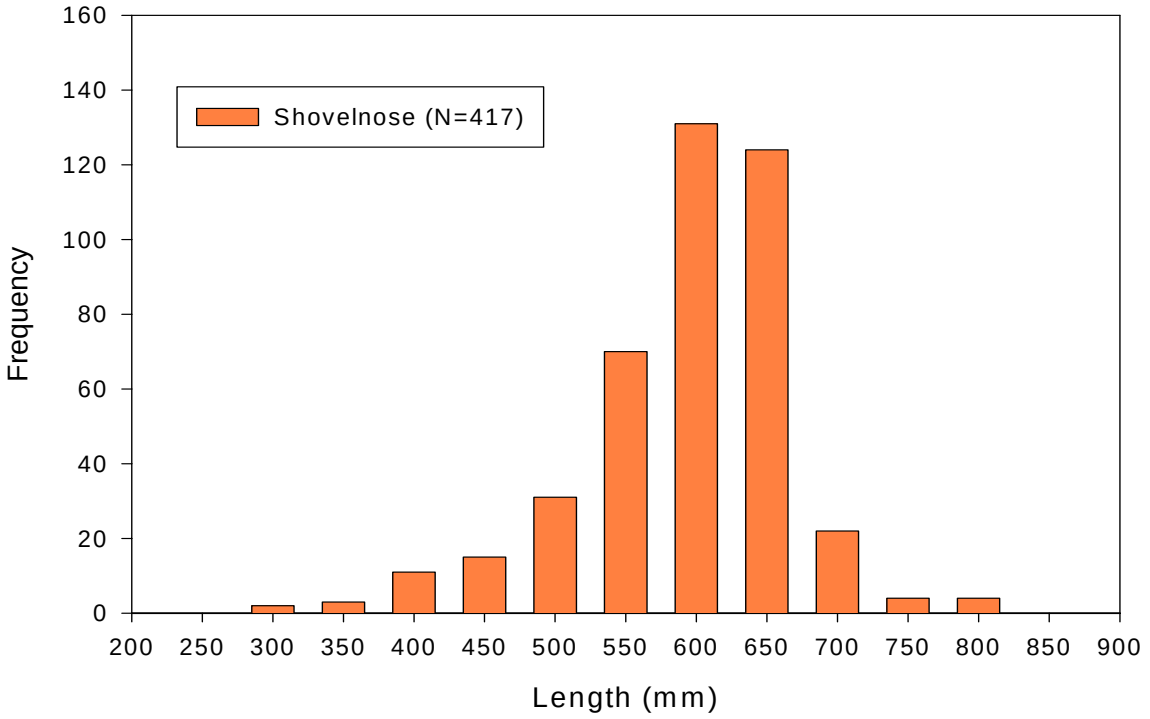

Figure A4. Length frequencies for shovelnose sturgeon captured in gillnets at Plowboy Bend on the Lower Missouri River in 2002.

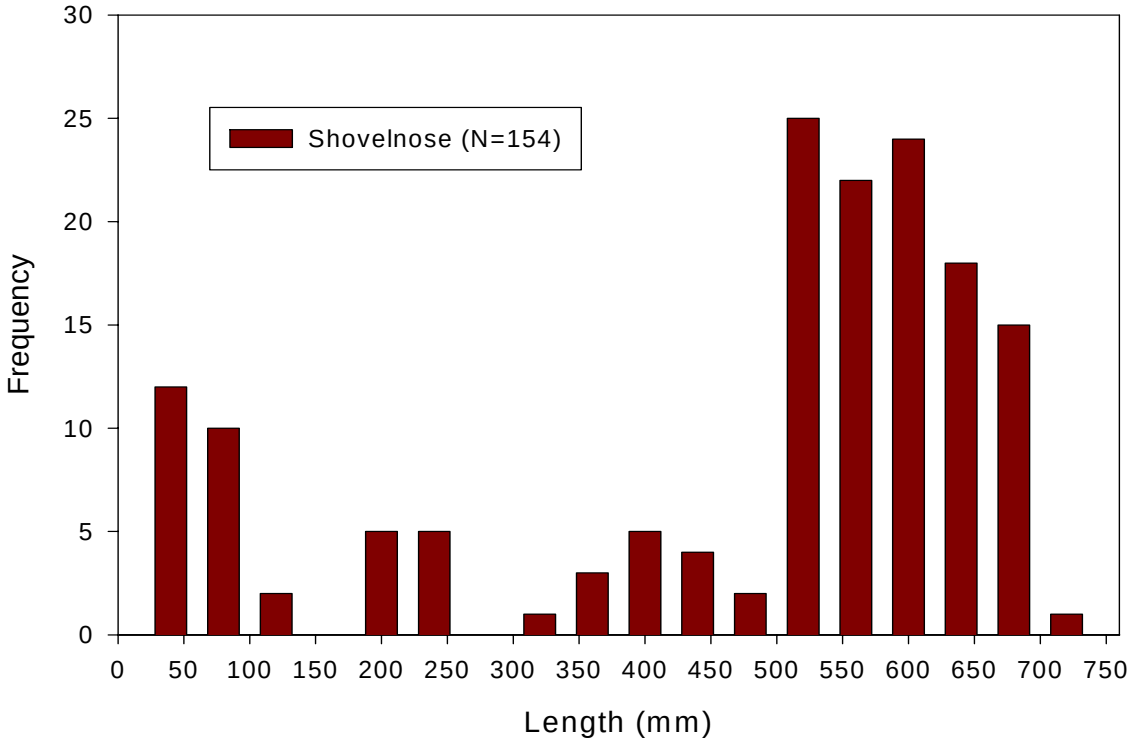

Figure A5. Length frequencies for shovelnose sturgeon captured in trawls at Overton Bottoms on the Lower Missouri River in 2002.

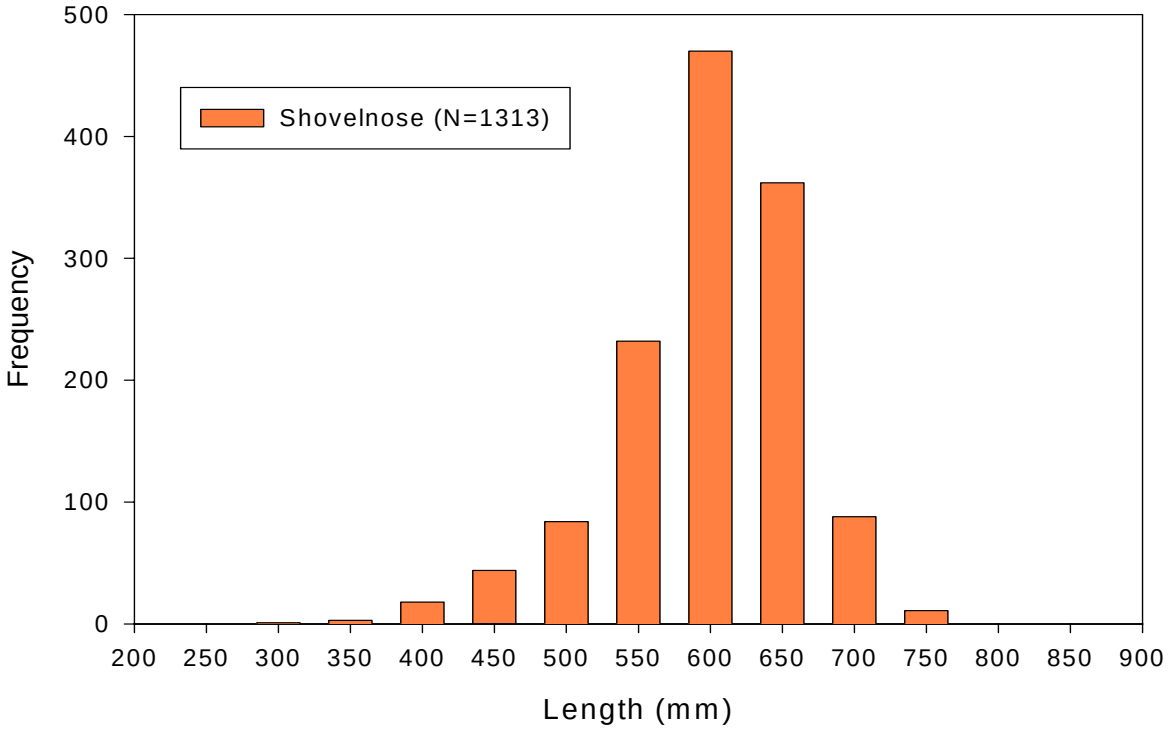

Figure A6. Length frequencies for shovelnose sturgeon captured in gillnets at Overton Bottoms on the Lower Missouri River in 2002.

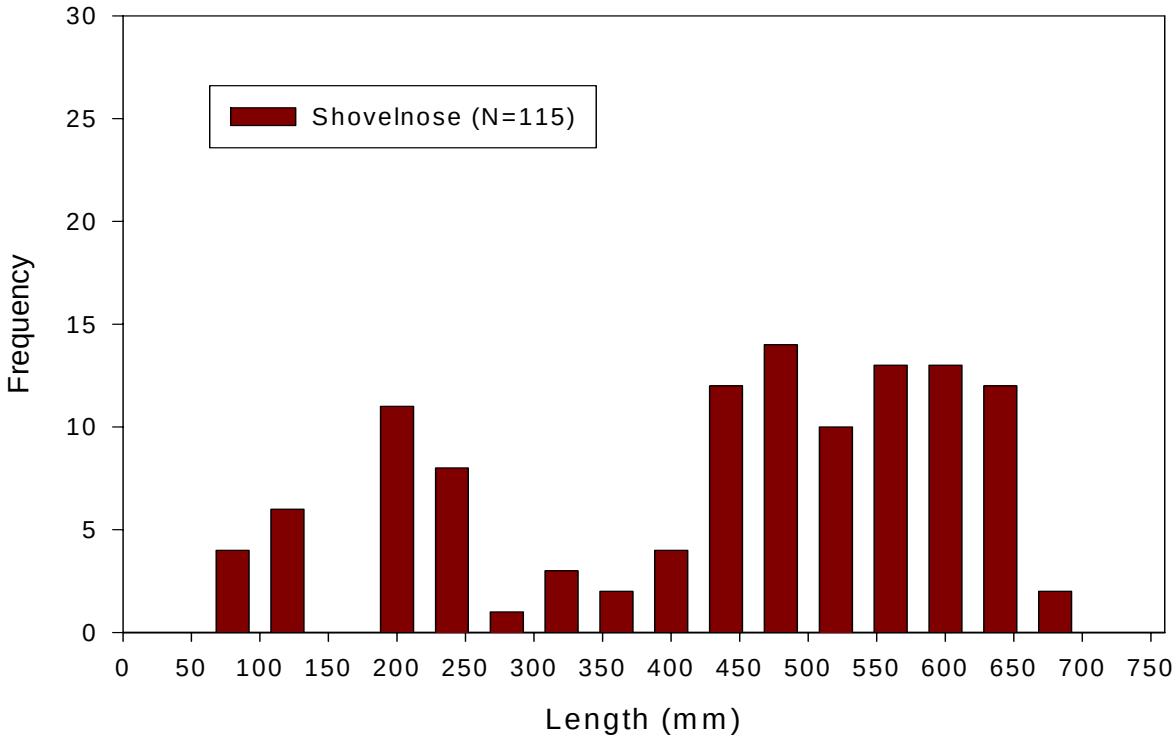

Figure A7. Length frequencies for shovelnose sturgeon captured in trawls at Lisbon Bottoms on the Lower Missouri River in 2002.

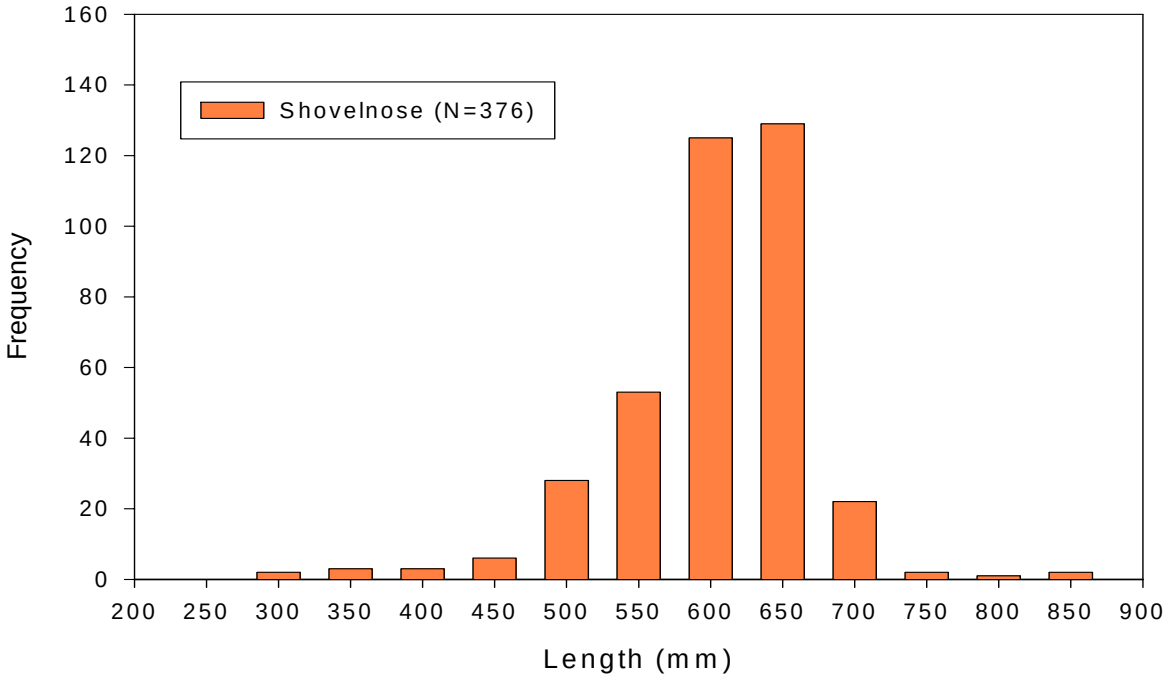

Figure A8. Length frequencies for shovelnose sturgeon captured in gillnets at Lisbon Bottoms on the Lower Missouri River in 2002.

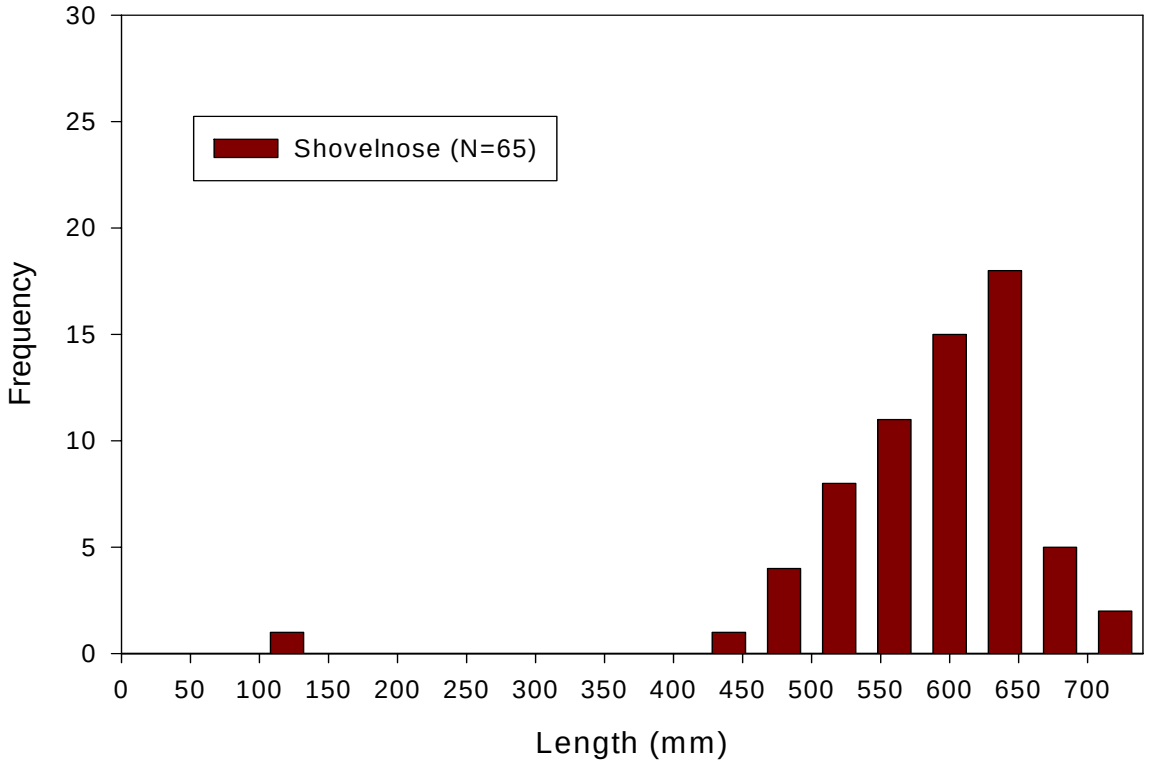

Figure A9. Length frequencies for shovelnose sturgeon captured in trawls at Hermann on the Lower Missouri River in 2002.

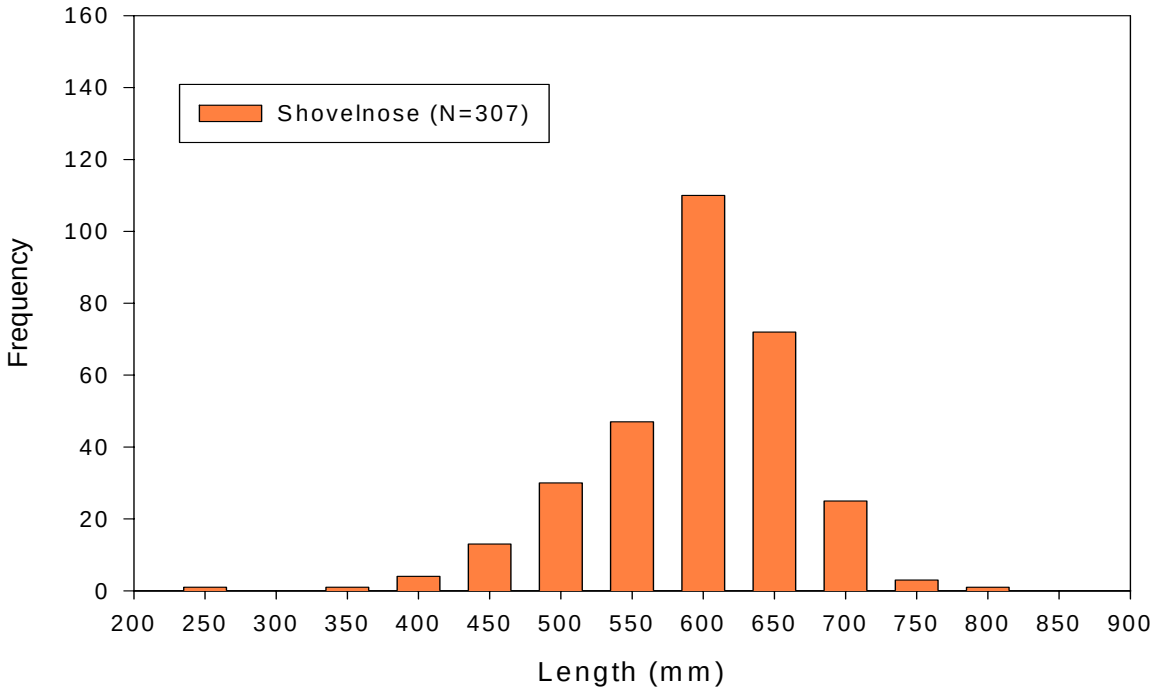

Figure A10. Length frequencies for shovelnose sturgeon captured in gillnets at Hermann on the Lower Missouri River in 2002

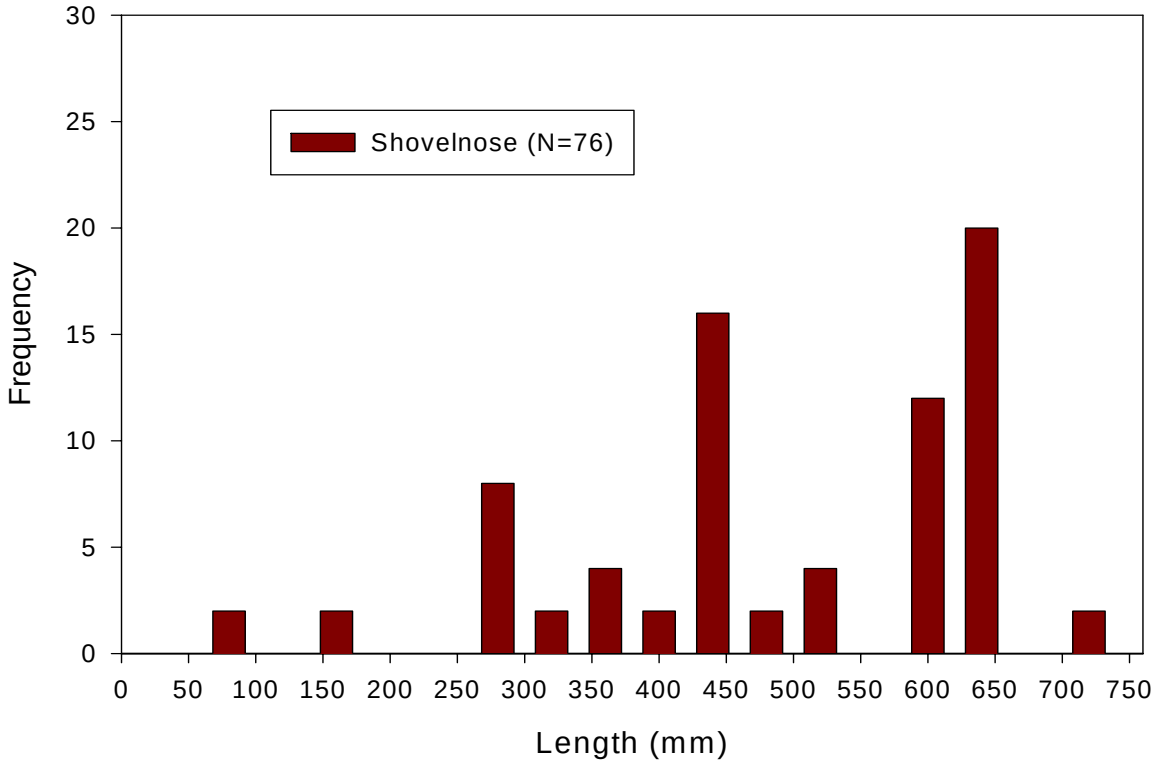

Figure A11. Length frequencies for shovelnose sturgeon captured in trawls at St. Charles on the Lower Missouri River in 2002.

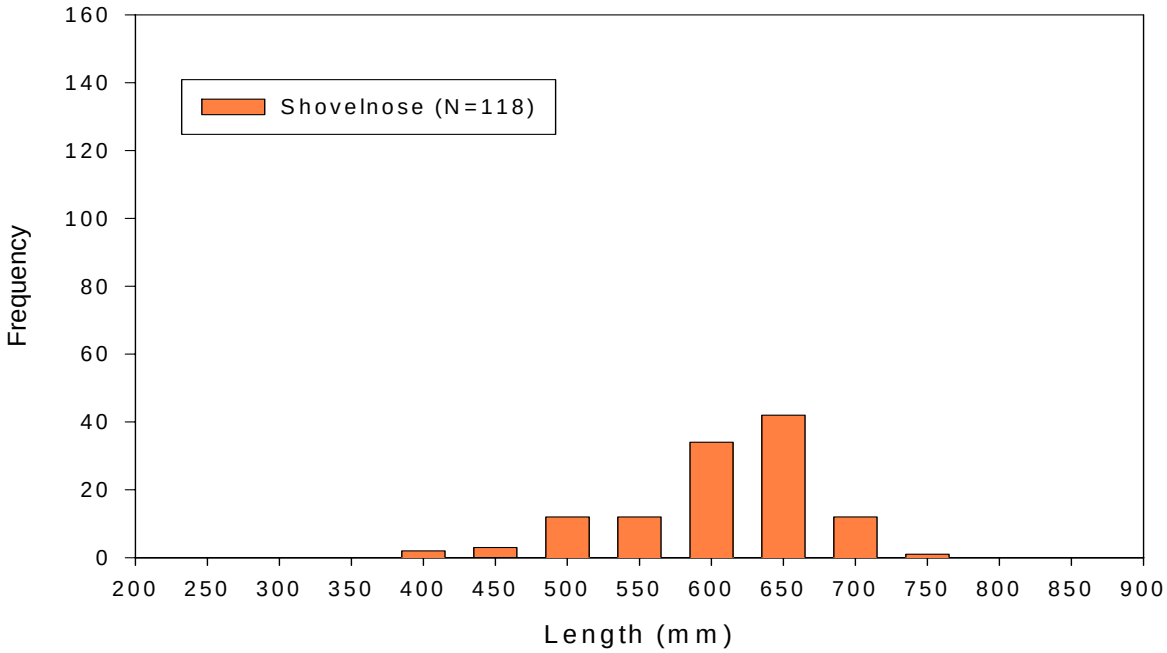

Figure A12. Length frequencies for shovelnose sturgeon captured in gillnets at St. Charles on the Lower Missouri River in 2002.